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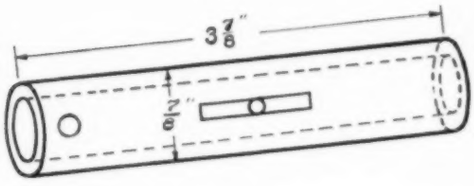

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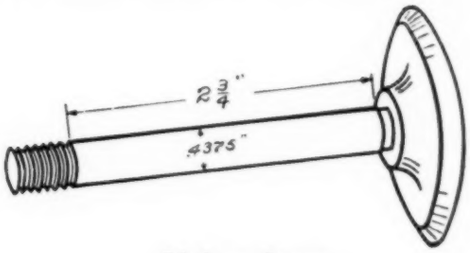

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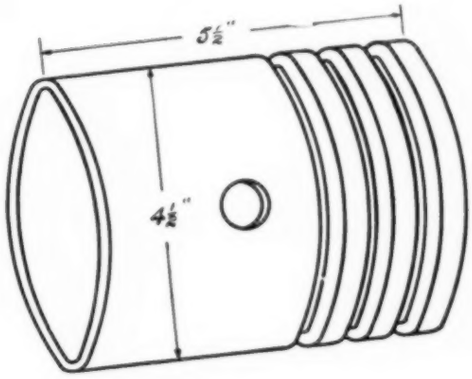

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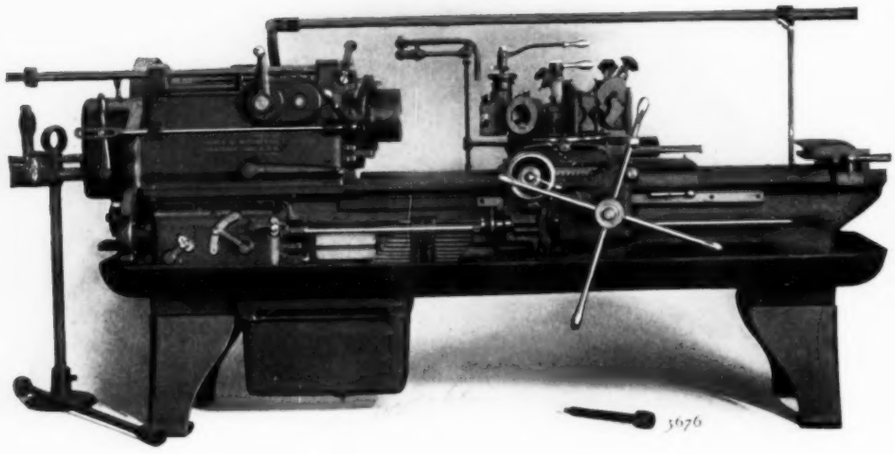

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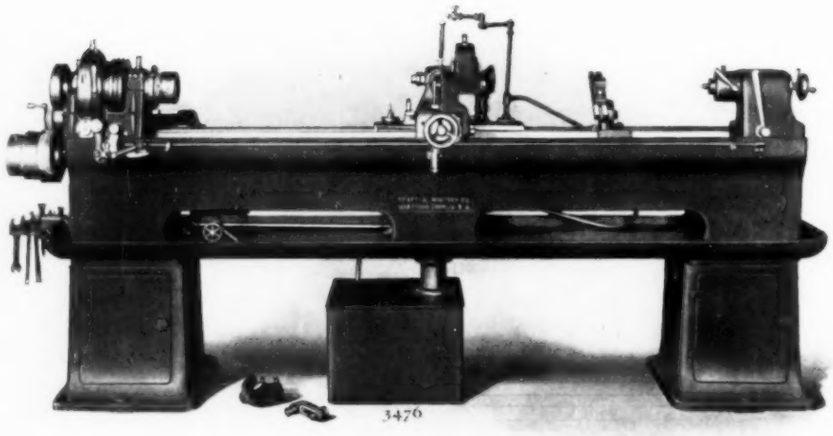

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The Economy and Work of Lifting Magnets

Savings Effected by Cleaning Scrap from the Ground, Floors, Cars, Etc. The Many Uses Given Them and the Saving in Labor

BY E. F. LAKE

Lifting magnets have been in use for a number of years and yet but few people realize the extent to which they are used or the amount of saving actually effected by them in the course of a year. In a recent visit to some of the large machinery-building plants of the middle West, I observed a number of instances where very material economy was being effected.

At the West Allis works of Allis-Chalmers Company, for example, lifting magnets are not only used exclusively in the yards for unloading, loading and otherwise handling bars of pig iron, scrap, small castings and machinery parts of medium size, as shown in Fig. 1, where the magnet is used for picking up iron knuckles and loading them into charging buckets, which conveys them to, and dumps them into the cupola, but they are also pressed into service for saving the small pieces and even minute particles of iron and steel which have heretofore been allowed to go to waste without thought of the possibility of recovery.

FIG. 1. MAGNET IN FOUNDRY YARDS OF ALLIS-CHALMERS COMPANY LOADING CUPOLA CHARGING BUCKETS

This is done periodically by hitching the magnets to traveling cranes and allowing them to sweep over every inch of ground area, both in and around the works. Out some distance from the buildings and along the railroad tracks, where the regular shop and yard cranes cannot reach, a locomotive crane, as shown in Fig. 2, serves the purpose, by using the vast network of cross-tracks with which the yards are supplied, and it is a never-failing source of wonder to the shops' management how much lost metal the magnets find.

The first time they were put to this use a goodsized trainload of old iron was recovered; pieces which had laid buried in the ground for years leaped through their earthen mantle to meet the magnet, and not a few mysterious disappearances of parts reported "missing" were accounted for in this day of reckoning.

One place where the magnet was used for cleaning up the foundry, the ground would swell up over a piece that was too

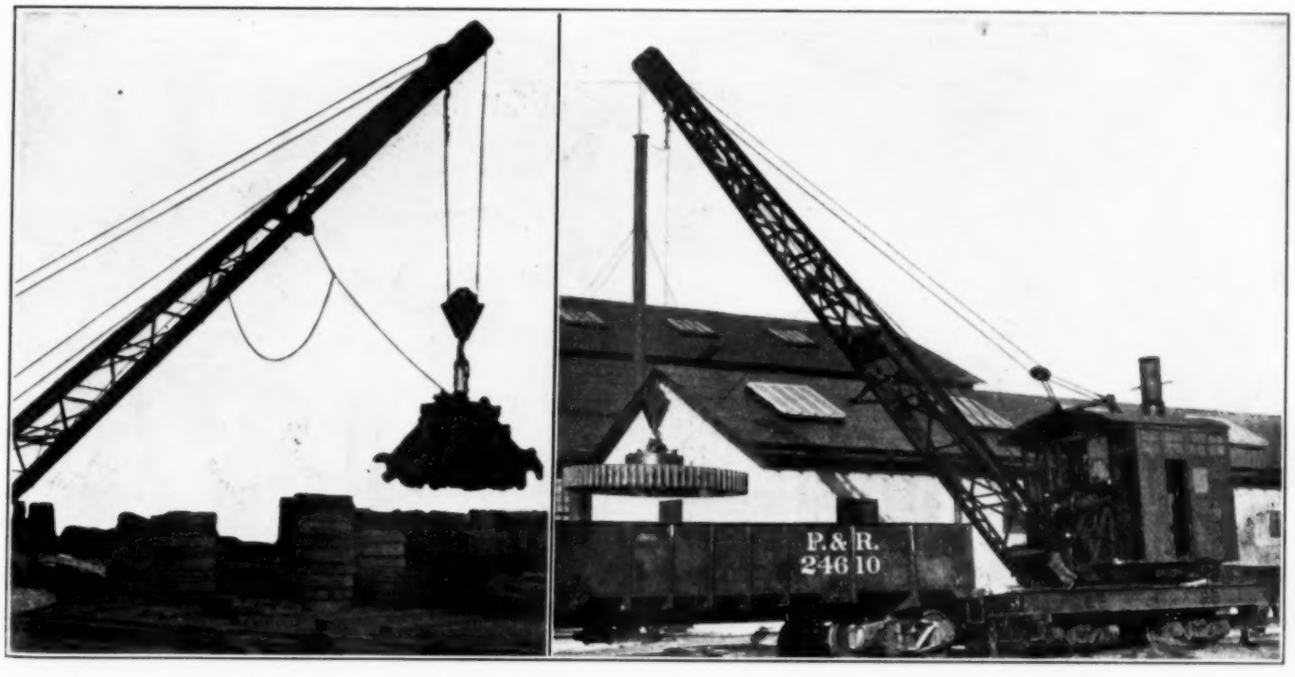

FIG. 2. LOCOMOTIVE CRANES MOVING WORK WITH BROWNING ENGINEERING COMPANY'S MAGNETS. GEAR WEIGHS 8160 POUNDS

deep in the sand to be lifted out. These were dug out and some of them proved to be mistakes of the molders that had been purposely buried.

Cleaning Cars and Casting Floors

Practically nothing now gets away, as even the particles escaping as sparks from the cupolas settle before passing the limits of the works and are drawn again to the magnets when these next make their rounds. In the foundry the recovery of sprues, gates, shot, overplus, etc., is, of course, greatly facilitated by the new method, and nothing is too insignificant to escape the all-attracting magnet.

In Fig. 3 is shown an Electric Controller and Manufacturing Company, Type F., No. 7 magnet that has been passed over the ground to pull the scrap metal out of it.

Another instance of economies happened in a foundry which ordered a car in which to ship castings and found that the empty car had previously contained pig iron, considerable of the chips and dust from which remained. A magnet lowered into the car picked up six hundred pounds of this waste, equivalent to finding a five-dollar bill. The magnet is also successfully used to draw shot from the sand of a blast-furnace cast house. This sand being used over and over again becomes filled with small globules of iron, called "shot" and it was formerly riddled to remove this shot, but in one case a magnet drew out nearly 300 pounds of shot for every 60-inch length that it was moved over the bed of sand. The magnet was about 4 inches above the sand and 60 inches long as shown in Fig. 3. In open-hearth plants the magnet is used to "sweep up" any small pieces of iron left along the track after charging the boxes.

Handling Foundry Metals

At the works of The Falk Company, of Milwaukee, operating the largest all-steel foundry in the West, as well as an extensive machine shop, figures were given showing the saving effected by the use of a magnet in handling pig iron, scrap, etc., before charging to the furnaces. Thus a 30-ton gondola car of pig iron was unloaded without a magnet by five men in 1½ hours and the same was unloaded with a magnet, as shown in Fig. 5, by two men in 1 hour (or less). In unloading knuckles a 50-ton car was unloaded without a magnet by five men in 4 hours while the same was unloaded, with a magnet, by two men in 1½ hours.

Taking the figures of their annual production, and including all offsets, this amounts to a saving to The Falk Company of not less than $5000 per year. As a matter of fact, however, it is more; for, in rehandling the iron to the furnaces, the figures for unloading cannot be taken as a fair basis, the cost per unit of weight being greater. With the Allis-Chalmers Company, whose cupolas at the West Allis works alone are stated in one of that company's publications to have a capacity of 520 tons daily, the same ratio of saving would indicate an economy so tremendous as to be well nigh unbelievable. With The Falk Company's figures as a basis, any manufacturer can figure

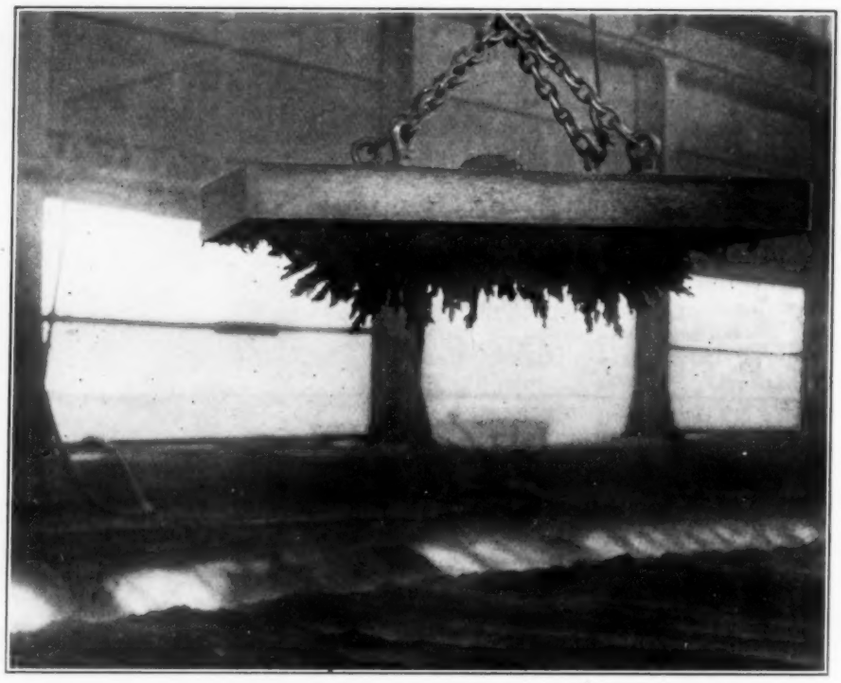

FIG. 3. ELECTRIC CONTROLLER AND MANUFACTURING COMPANY'S MAGNET CLEANING UP THE SCRAP

FIG. 4. ELECTRIC CONTROLLER AND MANUFACTURING COMPANY'S NO. 2 MAGNET LIFTING CAST PIGS

FIG. 5. BROWNING ENGINEERING COMPANY'S MAGNET UNLOADING CHILLED IRON PIGS FROM STEEL CARS

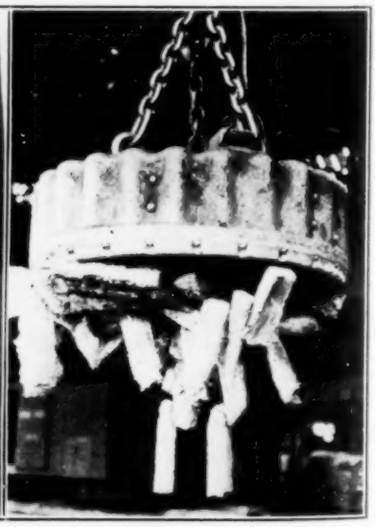

FIG. 6. CUTLER-HAMMER 50-INCH MAGNET HANDLING MANGANESE IRON PIGS

out the possible economy of this system as applied to the handling of iron and steel at his own plant.

In Figs. 4, 5 and 6 will be seen three different makes of magnets which are lifting and carrying different kinds of pig iron from the steel gondola to the ore pile or from the ore pile to the furnace, etc., while Fig. 7 shows one lifting and carrying a sow and pigs from the mold to the breaker.

Loading and Unloading Cars

Some of the good features of the lifting magnet are that it is simple in construction, comparatively small, and can be easily attached to any kind of a lifting, swinging or traveling crane. In Fig. 2 is shown two 36-inch magnets on locomotive cranes, one of which is lifting 26 broken draw bars with a total weight of 4160 pounds and the other a gear weighing 8160 pounds.

Some idea of the normal efficiency of a 50-inch pig magnet operating under service conditions may be obtained from records of tests. In large plants manufacturing iron and steel products many lifting magnets are employed for handling pig iron, scrap, etc., and a test was given one of these at the works of the Youngstown (Ohio) Sheet and Tube Company. The result of this test was that one man—the crane operator—using the magnet, unloaded a steel gondola containing 109,

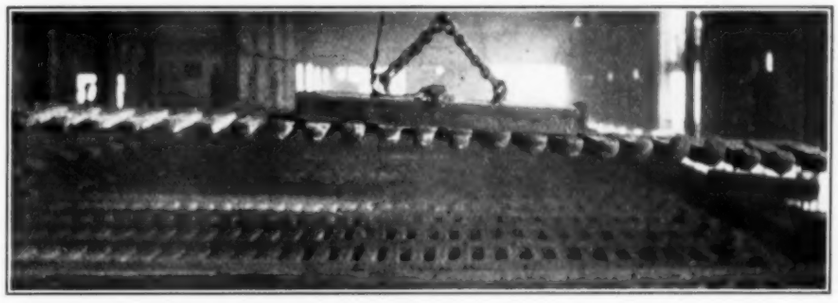

FIG. 7. ELECTRIC CONTROLLER AND MANUFACTURING COMPANY'S MAGNET LIFTING A SOW AND PIGS

ton, depending on local conditions, and the average ran about 8 cents, even where the stock yard was covered by cranes and the laborers simply filled charging boxes which were afterward handled to the buggies by the crane. This cost of handling stock from the cars to the charging boxes in open-hearth furnaces, with magnets, has been reduced to

55 tons of railroad scrap into one car in 55 minutes with one man operating the crane on which was a 36-inch magnet. In scrap material consisting of nuts, bolts, etc., the same magnet has loaded 115,000 pounds in one hour. By the hand methods necessarily in use before the magnet was perfected, the cost of unloading scrap iron in open-hearth stock yards, varied between 5 and 12 cents per

and with only one man, in a crane cage, what by hand methods took two different handlings and some 16 laborers to perform. The saving will not only pay for the magnet in a short time, but also the necessary outlay for the crane and runway will be paid for in less than two years.

The lifting magnet has been made practically universal in its application, and the one in use by the P. R. R. at Greenville, N. J., is used to handle all of the magnetic material arriving at its dock for transferring to lighters for ocean shipment or delivery in New York City.

They are handling there cast-iron pipe 3 inches in diameter that weigh 2000 pounds; cast-iron sections for the retaining wall of the East river tunnel

FIG. 8. TYPE S MAGNET AT P. R. R. DOCK

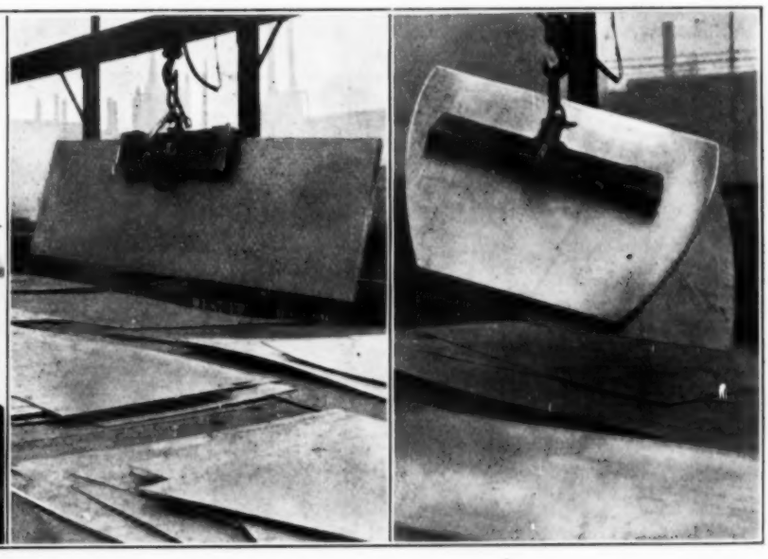

FIG. 9. ELECTRIC CONTROLLER AND MANUFACTURING COMPANY'S TYPE F MAGNET HANDLING SHEET STEEL

350 pounds of pig iron in two hours and five minutes. The average weight of metal moved, per lift, was 789 pounds. The current required to energize the magnet was 30 amperes at 220 volts. The cost of current consumed by the magnet during the period required to unload the 54 tons of pig iron was less than 25 cents.

Another test that was conducted at the L. S. & M. S. R. R. shops at Collingwood, Ohio, resulted in the loading of about 2 cents per ton, and in a great many places where only one handling is necessary, they are doing it at less than 1 cent per ton.

Some Common Applications

One foundry has installed crane facilities at their new plant so as to handle pig iron either from the cars or stock pile to the charging floor of their cupola with a magnet and thus do with one operation

that weigh 4000 pounds. These are concave on one side and convex on the other and of a radius to conform to the diameter of the tunnel; paper-filled car wheels; steel pipe 5 inches in diameter and 30 feet long, weighing 3000 pounds; upright steam boilers, handled from an upright position, each boiler weighing 14,000 pounds; new rails, 100 pounds per yard and 30 feet long, when evenly arranged in the car, are lifted eight rails per lift,

total 8090 pounds; plate, about 4080 pounds per lift, and other things too numerous to mention.

In Fig. 8 will be seen the magnet at the P. R. R., Greenville, N. J., docks at work loading a lighter. With this magnet four men unloaded a carload of wheels in one hour, while with the old method it took six men, one-half of a day, to unload a carload of the same size. To the right of this, in Fig. 9, is shown the same company's type F magnet handling sheet steel. Fig. 10 shows a magnet as used by The Falk Company, of Milwaukee, Wis.

Economical Uses

One of the most common uses to which lifting magnets are now put is in handling skull crackers for breaking up scrap slag, etc., in foundries and steel plants as shown by Fig. 11. Its use does away with the necessity of a latch-eye and the consequent usual loss of time in turning the ball so that the eye may be engaged by the hook. There is also much more positive action, as the skull cracker is not deflected from its aim by the jerking of the hook when releasing it and every shot tells in the most effective manner, while accidents to the ground men are practically obviated. After a pile of scrap has been broken and thereby scattered, it can be much more quickly assembled in loads by the magnet, thus gaining still further on the economy in time and labor obtainable under ordinary circumstances.

For loading and emptying cars of very light stock, such as "farmers" scrap, iron junk, small plates and tubing, wire, lamination punchings, light structural shapes, angles, small castings, foundry flasks,

FIG. 11. MAGNET LIFTING SKULL CRACKER BALL

knuckles, wheels, runners, shafts, casings, hoops, stove or furnace sections, unfinished hardware, etc., the magnet is particularly serviceable; while for bulk nails, tacks, bolts, nuts, turnings, borings, facings, etc., it far outstrips any other method of handling. As an instance of this, one has only to consider the very common necessity in large machine shops of removing such waste from the mill or lathe pits. When, say, half a ton has been allowed to accumulate it takes a man several hours to convey it away, with the aid of an industrial car; whereas a magnet reduces the operation to a few minutes' time.

Nor does the service of the magnet stop at rough material. Any machined part or manufactured article, except in very heavy sizes, can be moved about by this means; as, for example, forges, safes as shown by Fig. 12, flywheel sections, iron penstock, steel tubes, rock crushers, stamp mills, or almost anything securely put together and having enough iron or steel in its construction to respond to the pulling power of the magnet.

Hoisting Tackle Eliminated

Wherever the above materials are handled, lifting magnets can be advantageously employed. The time saved, due to the fact that the use of a magnet eliminates the necessity of adjusting hoisting tackle to the object to be raised, is oftentimes of itself sufficient to justify the installation of a lifting magnet. Particularly in the case of pig iron and scrap metal are the practical advantages of the magnet obvious, owing to the large number of pieces that can be handled at a single lift, and to the fact that the pieces so handled need not be piled be-

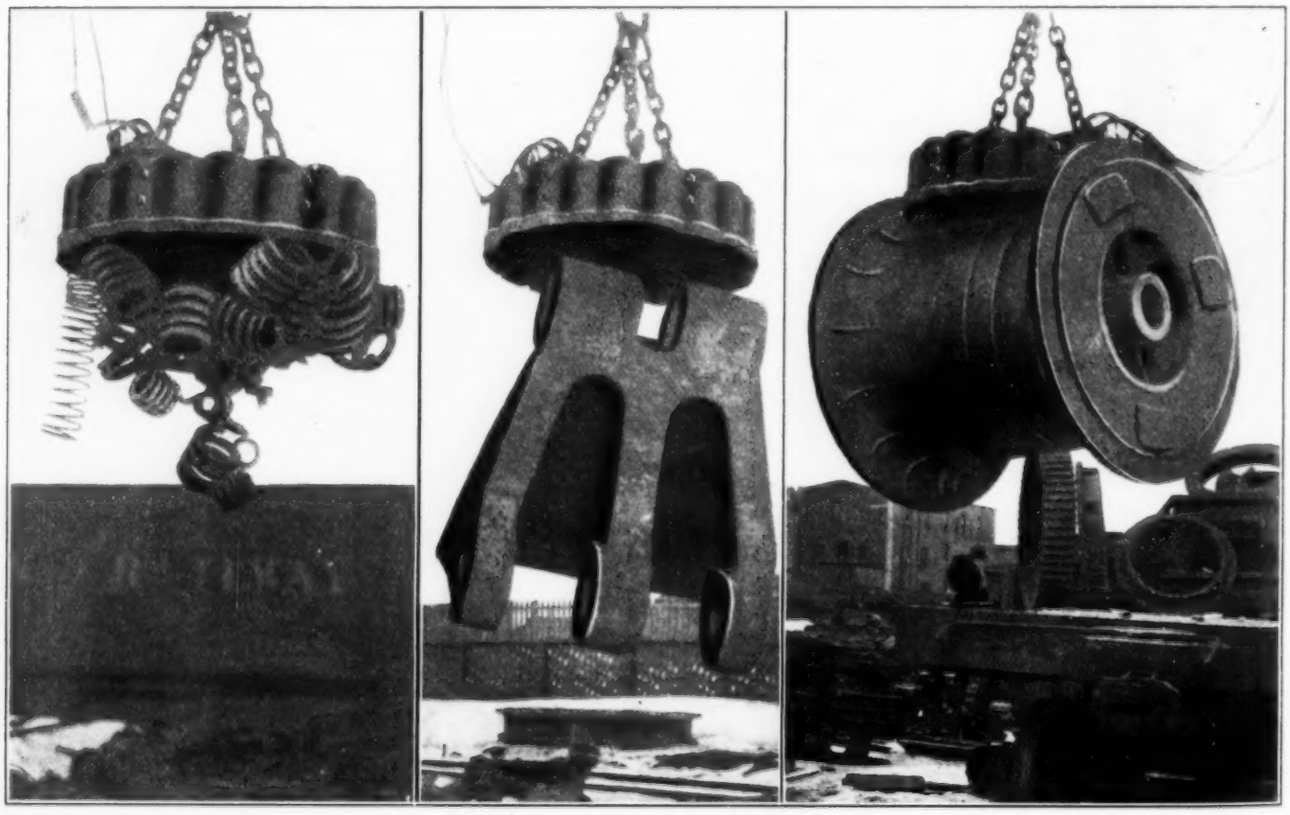

FIG. 10. CUTLER-HAMMER MAGNET IN THE FALK COMPANY WORKS LIFTING CAR SPRINGS, A CASTING WEIGHING 3000 POUNDS, AND A WINDING DRUM

forehand. All that is necessary in work of this sort is to lower the magnet onto the pile of pigs or scrap, switch on the current—and lift. A further advantage of lifting magnets, and one that has led to their installation in many foundries and blast furnaces, is found in the fact that metal too hot to be touched with the fingers can be handled with a magnet as easily as cold metal. Castings which, because of their shape or because of unequal distribution of weight, require careful adjustment of hoisting tackle, and finished parts which would be liable to be chafed with chains, are examples of objects that can be more conveniently handled with lifting magnets than in any other way. Armor plate and thin sheets of iron or steel used in the manufacture of pressed steel or ironware, tubes, rails and a multitude of other finished or raw products forming part of the iron and steel industry are all capable of being ex-

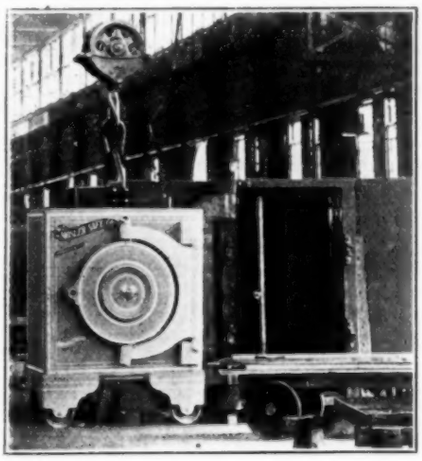

FIG. 12. MAGNET LIFTING SAFES

peditiously and economically handled by lifting magnets. The single limitation to the magnet's field of usefulness is, in fact, that the objects to be handled shall possess magnetic qualities.

Magnetic Attraction

So powerful are the lines of force of a 50-inch magnet that they will sustain the weight of a solid mass of metal weighing as much as 10 tons. If the load presented consists of a number of small pieces, the magnet will not pick up so much. One thousand to three thousand pounds of pig iron is a good lift for a 50-inch magnet, and even these weights will not often be attained except by an exceptionally good magnet operating under favorable conditions. The efficiency of electromagnets depends upon so many contingencies that no manufacturer of lifting magnets can guarantee that his magnet will invariably handle a given number of pounds. Impurities in the metal constituting the load, inequalities of surface, the proximity of other magnetic material to the objects to be lifted—these and many other conditions tend to influence the lifting capacity of the magnet.

It is significant that no establishment that has tried the lifting magnet has ever returned to the old method of handling iron and steel, and it is safe to say that at no very distant date the lifting magnet will be considered as indispensable as that other labor-saving device with which it is associated—the electric crane.

Riveting for Built-up Girders

By Con Wise

To many the figures for the spacing of rivets in girders is a mysterious matter, due, to my mind, more to the way in which the problem is attacked in text books than to any real difficulty in the problem. The usual method of attack is to develop the theoretical distribution of vertical shear over a rectangular beam, prove that the horizontal shear at any point is the same as the vertical, and then show that the shear under the flange of a beam of I-section is approximately what would be obtained by dividing the total vertical shear at that point in the length of the beam by the depth between the flanges.

From my point of view, I find it easier to first consider a girder as if it was a pin and link structure, similar to that shown in Fig. 1, where the horizontal lines represent the tension and compression members corresponding to the two flanges of a beam, and the vertical members serve to keep the horizontal ones correctly spaced. The dotted diagonal lines represent the braces which would be necessary to complete a truss and, with the vertical members, perform the functions of the web in a plate girder. Now if we suppose the total load on this girder to be W pounds uniformly distributed, we shall have $\frac{W}{8}$ pounds at each joint except at the ends, where only $\frac{W}{16}$ is carried. The supports each carry $\frac{W}{2}$.

If we consider the tension in the members AB, BC, etc., we can find their values by taking moments about points in the top member of the truss as at c, to find AB. Thus the stress in AB =

$$\frac{4a\left(\frac{W}{2}\right) - a\left(\frac{W}{8}\right) - 2a\left(\frac{W}{8}\right) - 3a\left(\frac{W}{8}\right) - 4a\left(\frac{W}{16}\right)}{h} = W\left(\frac{a}{h}\right).$$

The stress in BC =

$$\frac{3a\left(\frac{W}{2}\right) - a\left(\frac{W}{8}\right) - 2a\left(\frac{W}{8}\right) - 3a\left(\frac{W}{16}\right)}{h} = \tfrac{13}{16} W\left(\frac{a}{h}\right).$$

The stress in CD =

$$\tfrac{3}{4} W\left(\frac{a}{h}\right).$$

The stress in DE =

$$\tfrac{7}{16} W\left(\frac{a}{h}\right).$$

The stress beyond E = 0.

Now since AB and BC are joined by a pin at B, the shear on that pin, which corresponds to a rivet in our girder, is equal to the difference in stress on AB and BC, or, in this case,

$$\frac{W}{16}\left(\frac{a}{h}\right);$$

between BC and CD at C it is

$$\frac{3W}{16}\left(\frac{a}{h}\right)$$

and between CD and DE it is

$$\tfrac{3}{16} W\left(\frac{a}{h}\right).$$

At E it is

$$\tfrac{7}{16} W\left(\frac{a}{h}\right),$$

or the difference between the stress beyond E and that in DE. It will be observed that the vertical shear at or to the

FIG. 1

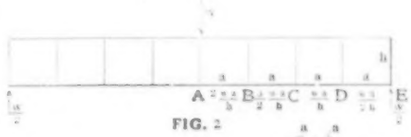

FIG. 2

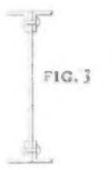

FIG. 3

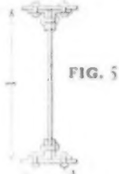

FIG. 5

DIAGRAMS ILLUSTRATING RIVETING OF BUILT-UP GIRDERS

left of B is $\frac{3}{16} W$, and to the left of C it is $\frac{5}{16} W$, etc., so that in each case if

$$\frac{a}{h} = 1$$

the stress on the pin or rivet is equal to the total vertical shear at that point in the length of the beam. This condition that

$$\frac{a}{h} = 1$$

is obviously met by making $a = h$, or by dividing the beam into squares by the vertical members. It will be noticed also that the shear at each successive upright increases in arithmetical progression as we go away from the center of the girder. This agrees with the shear diagram derived by other means for a uniformly loaded beam.

Referring to Fig. 2 we see that the *difference* in tension between *A B*, *B C*, *C D*, *D E* is the same at each pin, which also agrees with the shear diagram as usually drawn. This gives us the stress on each pin as $\frac{W}{2}\,\frac{a}{h}$ or, if a is made equal to h, simply gives us $\frac{W}{2}$, which is the same as the total vertical shear. Thus we conclude that in either method of loading the horizontal shear over a length of the beam equal to the depth between rivets is the same as the total vertical shear at the corresponding point.

If the girder is of the section indicated in Fig. 3, the similarity to an open-work truss is apparent. To be sure, the upper and lower chords are not jointed at the rivets, but since all parts are in direct tension, or compression, this will not alter the relations of the rivets and the web which has to take the shear stresses for the most part. As the function of the rivet is to transmit the forces acting on the flanges, or in this case the angle irons, to the web, it is evident that it is only necessary to put enough rivets in a length of the beam equal to its depth to carry the total vertical shear on the beam at the point under consideration.

An Example

For example, suppose that we have a beam whose depth between rows of rivets is 20 inches, loaded at the center with 40,000 pounds. The shear at each side of the center is equal to one-half the total load, or 20,000 pounds. This in turn is 1000 pounds per 1 inch of length or depth. Now if we expect to use ¾-inch rivets we see by the table, Fig. 4, that it will carry 2650 pounds in single shear. In the case shown the rivets are in double shear, and will carry 5300 pounds each. If only 1000 pounds per 1 inch of length is to be carried, only one rivet in 5.3 inch will be required to carry it. In a similar way the spacing with ⅝-inch or ⅞-inch rivets may be found. This spacing would be right if nothing was to be considered, but the possibility of the rivets shearing off. If the web is too thin, or the flanges of the angles are too thin, there is a possibility of the rivets crushing in the holes. In the table, Fig. 4, bearing values are given for rivets in different thicknesses of plates without exceeding a fiber stress of 12,000 pounds per square inch. If in this case the web is ⅜ inch thick the bearing value is 3375 pounds, much less than the shearing value for one rivet per 3.375 inch of length. That is, the spacing is equal to the shearing value or the bearing value, whichever is smaller, divided by the shear per inch of depth between rivets.

In Fig. 5 *a*, *a* are rivets for a cover plate. The method of computation is the same as before, but care must be taken in computing the shear to be carried by the rivets to take the total depth *b* to the points where the rivets might shear off. In computing the bearing value it is customary to use the same depth, though it is evident that it would be more nearly correct to take it to the center of the depth of the cover plate, or the flange of the angle, whichever is the thinner. The rivets are in single shear in this case.

The table, Fig. 4, is taken from the Carnegie hand book, and is to be found in almost every engineer's hand book in more complete form than it is given here, with shearing and bearing values for more sizes of rivets and for shearing stresses from 6,000 to 12,000 pounds per square inch, and bearing values from 12,000 to 25,000 pounds. The selection of the values to be used is not usually left to men who do detail designing, but is determined by engineers who select their values with due regard to their past experience, and usually without being able to assign a logical reason for the particular values used.

Bracing of Web Plates

In deep girders vertical stiffeners, consisting of angle or T-irons riveted to the web, are necessary. As a general statement it may be said that the design of these stiffeners is left to the engineer's judgment. The method of procedure given above, however, indicates a way which may lead to a rational method of design. I will submit it for the criticism of the readers of the American Machinist, and trust that if it has weak spots they will be pointed out. In a truss of the outline of Fig. 1 the compression on each vertical member is the same as the shear on the outside of that member; that is, the compression on the vertical at *D* is

$$\frac{W}{2} - \frac{W}{16} = \frac{7}{16}\,W,$$

etc. If braces are put in, as shown by the dotted lines, they will be in tension only, and the beam will not require any stiffness to keep them straight. To be sure, if these vertical and diagonal members are replaced by a uniform web the web may act as either, or both, compression and tension members on the diagonal lines. But if it is so thin as to buckle under the diagonal compressive stresses, it may still hold under the tensile stress, so that it may be considered safely that the vertical members are all that need stiffness.

Under conditions which are likely to be met in these girders the straight-line formula for long columns is applicable. The formula is

$$\frac{P}{F} = 17{,}100 - \frac{57\,l}{K},$$

where P is the total load carried, F the cross-sectional area of the column, l its unsupported length in inches and K the least radius of gyration.

K is $\frac{b}{\sqrt{12}}$ for a rectangular section, where b is the thickness of the column in the direction in which it is likely to buckle; in this case b is the thickness of the web plate if it is not braced. The cross-sectional area of the column is F, which in this case may be taken as the thickness of the web multiplied by the spacing a which we are taking equal to h, except at the extreme ends where it should be taken as $\frac{a}{2}$. The vertical hight of the web should be taken as l. If $\frac{P}{F}$ is kept down to 12,000 pounds per square inch, which is common practice for such work then

$$\frac{l}{K} = 265,$$

or l should be about 76 times the thickness of the web as an upper limit beyond which stiffeners should be used. Of course, l is not the entire depth of the web, but the distance between the nearest edges of the angles. If stiffeners are needed it is obvious that very light ones will make K large enough to bring the ratio of $\frac{l}{K}$ safe. In fact so little is needed for this purpose that almost anything that is heavy enough to be easily riveted on is enough. Will your readers say how nearly correct this is?

Diameter Inches.		Area.	Single Shear 6000 per Sq. In.	Bearing Value for Various Plates—12,000 Pounds per Sq.In.									
				¼"	5/16"	⅜"	7/16"	½"	9/16"	5/8"	¾"	⅞"	1"
½	0.500	0.1963	1180	1500	2250	2630	3000						
5/8	0.625	0.3068	1840	1880	2340	2810	3280	3750	4220	4690			
¾	0.756	0.4418	2650	2250	2810	3380	3940	4500	5060	5630	6750		
⅞	0.875	0.6013	3610	2630	3280	3940	4590	5250	5910	6560	7880	9190	
1	1.000	0.7854	4710	3000	3750	4500	5250	6000	6750	7500	9000	10500	12000

An interesting engineering problem presented itself to the Crocker-Wheeler Company at Ampere, N. J., when it was found necessary to move a large oak tree about eighty feet in hight and weighing about 60 tons, from one section of the yard to another, in order to make way for a railroad siding. The interesting point was to decide on the proper place to grasp the tree with an 80-ton locomotive crane so that it might hang absolutely vertical and still permit the ropes and chains to be fastened low enough on the trunk to enable the crane to do its work. After proper calculations the transfer was performed and the tree moved 200 feet and successfully replanted.

The Construction of Graphical Charts

Proportional Charts Are Very Useful for Solving for Four Variables—The Z-chart and Its Modifications Are of Value for Certain Equations

BY JOHN B. PEDDLE*

A family of chart-forms of great structural simplicity is that which is known under the general name of the "proportional" or "parallel alinement" type. The ease with which they may be laid out and the fact that they may be used with certain forms of equations which can only be handled indirectly, if at all, by those types previously described are strong recommendations for their use in these cases.

Take any two lines meeting at any angle and lay off the distance a and b, as shown in Fig. 1. Connect the points at the ends of these lengths by a straight line and draw a parallel to it. It intersects the axes at the length c and d. From similar triangles we have

$$\frac{a}{b} = \frac{c}{d}.$$

If, therefore, we lay off on one side of the vertical axis a scale for the values of a, and on the other side for c, and similarly, on the horizontal axis, the scales for b and d, we have a chart of great simplicity which takes account of four variables. Knowing a, b and c, for instance, we join a and b by a straight line and draw a parallel to it through c. This line intersects the d axis at the required value of that variable.

It may be advantageous, in certain cases, to have the scales graduated on separate lines instead of doubling up as was done with a and c or b and d. This is also shown in Fig. 1 where two lines parallel to the original axes have been drawn. The solution d' is found by drawing through c' a parallel to the original $a\,b$ line.

As an illustration of this type of chart take the Lamé formula for the strength of thick hollow cylinders subjected to internal pressure

$$\frac{D}{d} = \sqrt{\frac{f+p}{f-p}},$$

where D is the outside diameter of the cylinder, d the inside diameter (both in inches), f the fiber stress in the material and p the internal pressure (both in pounds per square inches).

Squaring both sides of the equation we have

$$\frac{D^2}{d^2} = \frac{f+p}{f-p}.$$

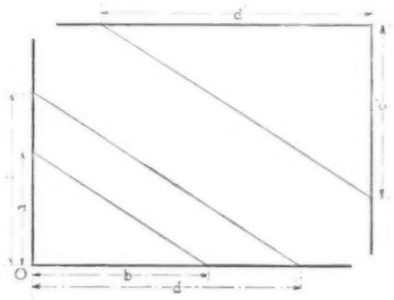

FIG. 1

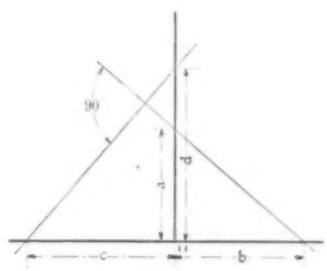

FIG. 3

FIG. 5

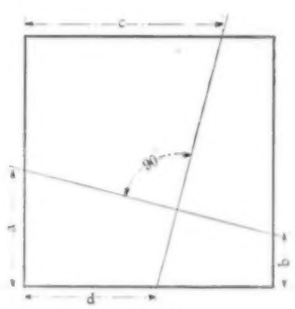

FIG. 6

DIAGRAMS OF PROPORTIONAL CHARTS

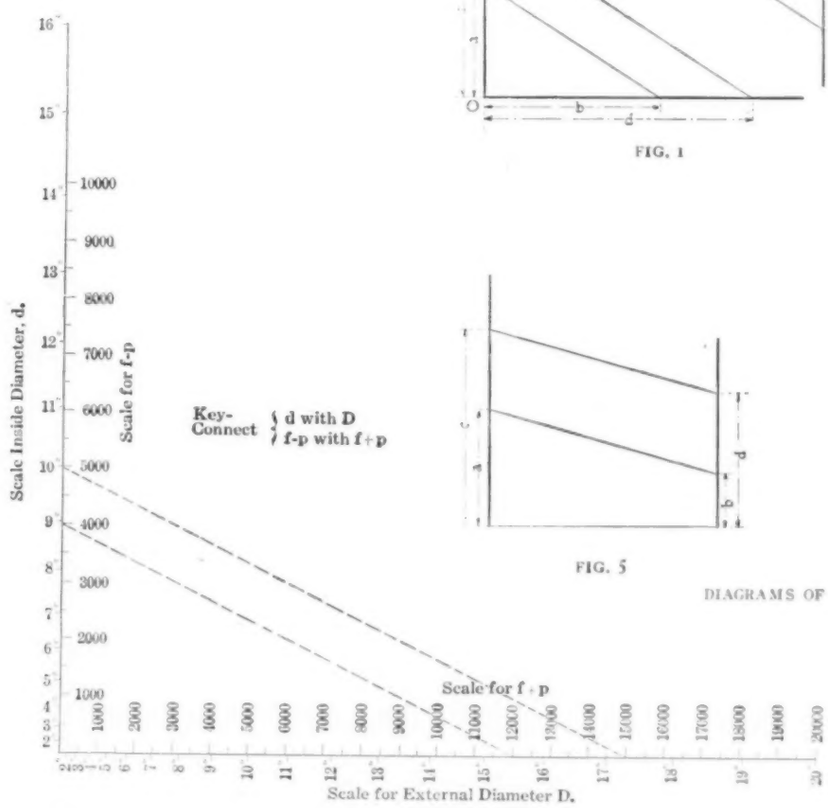

FIG. 2. PROPORTIONAL CHART FOR THE STRENGTH OF THICK HOLLOW CYLINDERS

This has the same form as the fundamental equation. Plot on the horizontal and vertical axes the desired values of D^2 and d^2. On the same axes plot as many values of $f+p$ and $f-p$ as may be deemed necessary. The scale units used for corresponding values on the two axes may be equal or not, as we please. In this case if we use equal scale units the horizontal axis will be considerably longer than the other, and the index lines are likely to cut it at a disagreeably acute angle. Accordingly the values of D and $f+p$ are laid off with a scale unit whose length is $\frac{2}{3}$ that used for d and $f-p$. On the chart the solution is shown for $f=8000$, $p=4000$ and $d=10$ inches, giving $D=17.3$ inches.

The only objection which might be raised against the chart just shown is the fact that a preliminary calculation—the addition and subtraction of the quantities

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f and p—is necessary before the chart is used. This, however, is not the fault of the chart but of the equation which was purposely chosen to bring up this point. A makeshift of this sort should, of course, be avoided where possible, but is often not objectionable. In this case where the values of f and p will usually be given in round numbers the necessary computations of $f+p$ and $f-p$ are easily made mentally and no serious difficulty will result. I have, however, seen this scheme used on a number of charts where it involved quite a little calculation or consultation of tables and where, on account of the complexity of the equation, it was evidently the only method which permitted it to be charted at all.

The Rotated Proportional Chart

This type of chart is susceptible of a slightly different arrangement which is sometimes considered advantageous. Suppose the lines carrying the quantities c and d, Fig. 1, to have been rotated about the origin, O, through 90 degrees. We will have a diagram like Fig. 3. In making this rotation the line joining the points which represent c and d will likewise turn through 90 degrees, and will be at right angles instead of parallel to that joining a and b. In reading such a chart it is generally customary to have a transparent index consisting of a sheet of thin celluloid with two lines, at right angles to each other, scratched on its lower surface. This is laid on the chart in such a way as to have one of the lines pass through a and b and the other through c. Its intersection with the d scale then gives the required value of that quantity. The same result may be obtained, of course, by a pair of draftsman's triangles laid against each other.

With this chart, as with the first one described, there is no need that the axes carrying a and d, or b and c should coincide. Every condition will be satisfied if the lines are separate but parallel. The advantage of this arrangement of chart over the other is not very marked, and I do not incline much toward its use. Some authorities, however, seem to look upon it with considerable favor and that is my main reason for referring to it at all.

Plotting of Formula of Resistance of Earth to Compression

One formula will be worked out showing its application. For this purpose let us take the formula for the resistance of earth to compression, used in calculations for foundations. It is:

$$P = w\,h\left(\frac{1+sin.\ \phi}{1-sin.\ \phi}\right)^2,$$

where P is the ultimate load on the earth in pounds per square feet, w is the weight of the earth in pounds per cubic feet, h is the depth in feet and ϕ the angle of repose of the earth.

The expression

$$\left(\frac{1+sin.\ \phi}{1-sin.\ \phi}\right)^2$$

may be treated as a single variable and the equation arranged

$$\frac{P}{h} = \frac{w}{\left(\frac{1-sin.\ \phi}{1+sin.\ \phi}\right)^2}.$$

This gives us the simple proportion we need for this type of chart. The limits were determined as follows: The friction angles given by Rankine for different conditions lie, roughly, between 15 and 45 degrees, though they exceed this in a few cases. To cover them all the graduations on the ϕ scale will be run up to 60 degrees, though it is probable that most of the values wanted will lie below 40 degrees. The extreme value of h was arbitrarily taken as 15 feet. The values of w given in the pocketbooks range from about 70 to 130 pounds. Taking h as 15 feet, w as 130 pounds, and ϕ as 40 degrees, we find P to be about 40,000.

Next let us choose our scale units. If we take the scale unit for h (which we will call l_1) as ¼, then $15 \times ¼ = 3¾$ inches, which is about the length wanted in the original drawing. For w let the scale unit (l_4) be taken as $\frac{1}{10}$. Then $130 \times 1/40 = 3¼$ inches, again a convenient length. For the ϕ-axis let the unit length (l_3) be $\frac{1}{0.04}$. The maximum value of the parenthesis containing ϕ is 0.347 when $\phi = 15$ degrees. Then $0.347 \times \frac{1}{0.04} = 8.675$ inches, which will be about right.

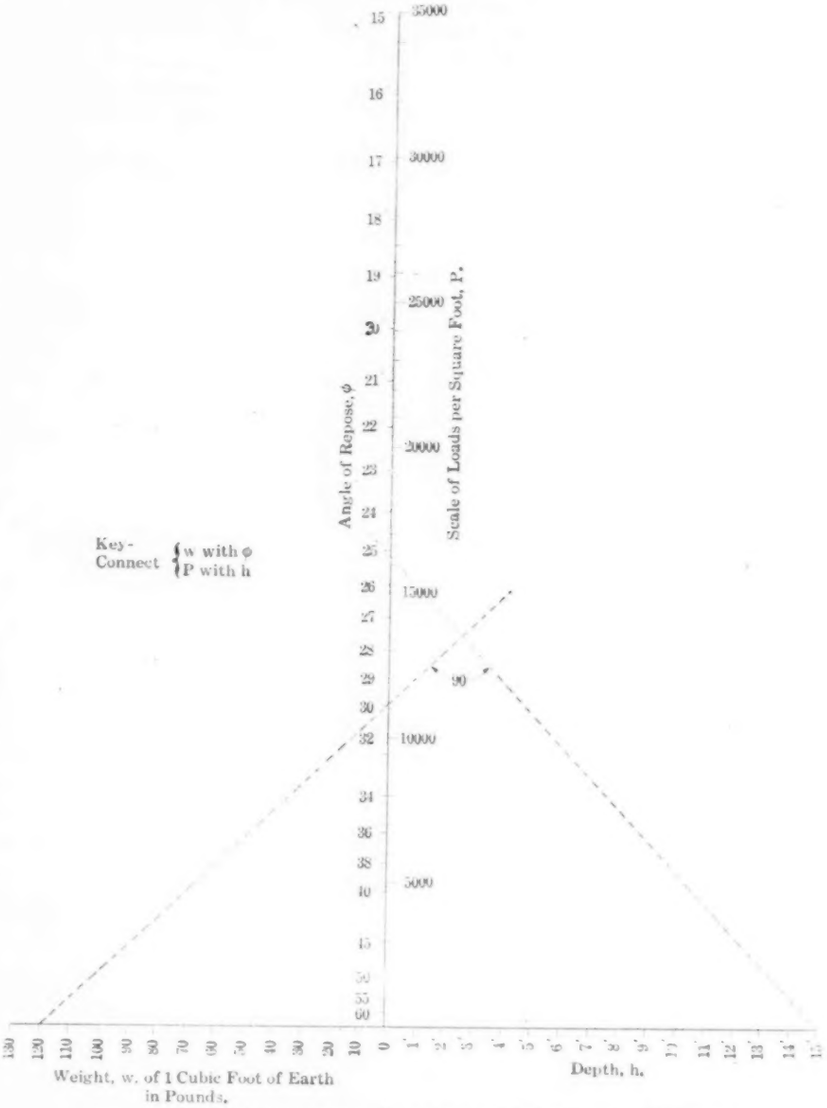


FIG. 4. PROPORTIONAL CHART FOR EARTH RESISTANCE IN COMPRESSION

Now the scale units should be in the same ratio as the quantities they affect. Hence, calling the scale unit for P l_2 we have

$$\frac{l_2}{l_1} = \frac{l_4}{l_3}, \text{ or } \frac{l_2}{¼} = \frac{\frac{1}{10}}{\frac{1}{0.04}}.$$

Then

$$l_2 = \frac{¼ \times \frac{1}{10}}{0.04} = \frac{0.04}{160} = \frac{1}{4000}.$$

Multiplying the maximum value of P by this unit we get,

$$40{,}000 \times \tfrac{1}{4000} = 10 \text{ inches}$$

as the length of the P axis. This was a trifle greater than I wanted for the limits I had placed on the size of the chart and I arbitrarily reduced it to about the same length as the ϕ-line, making the maximum value for P, 35,000. This would correspond to an angle ϕ of about 38 degrees with h and w at their maximum, and would probably cover most cases. It was, however, entirely a matter of convenience and there is no reason, in a practical case, why the scale should not extend as much further as the conditions in the problems likely to be encountered would seem to require. The graduation of the different scales is now an easy matter and the completed diagram is shown in Fig. 4.

The broken lines show the position of the index for $w = 120$, $\phi = 30$ degrees, and $h = 15$ feet, giving the load $P = 16{,}200$. This is, as stated above, the ultimate strength of the soil. If a fixed factor of safety may be used for all cases likely to be met with it might easily be introduced when P is plotted; that is, the numbers placed opposite the graduation marks on this scale would be divided by whatever factor we chose. Then the diagram would give us safe, instead of ultimate loads.

Charts with Parallel Axes for Sums or Differences

Next let us take a case like that shown in Fig. 5. Here the quantities are laid off from an arbitrary zero line on two axes which are parallel. Draw a transversal between the ends of the lengths a and b, and another parallel to it cutting the axes

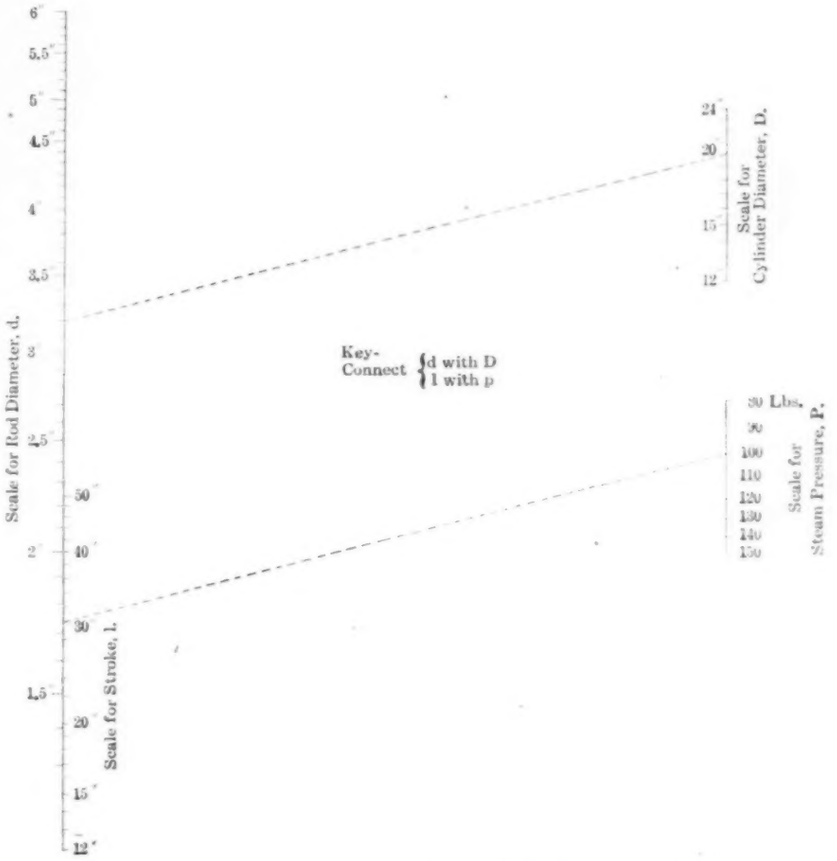


FIG. 8. PROPORTIONAL CHART TO DETERMINE PISTON-ROD DIAMETER

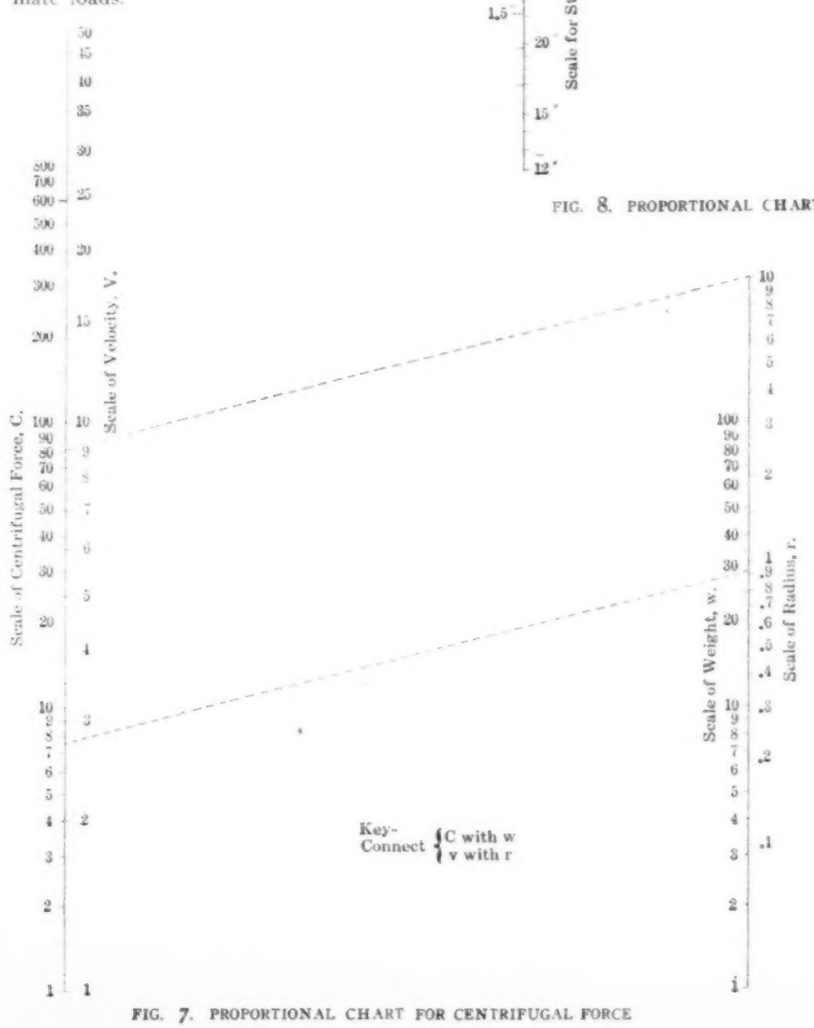


FIG. 7. PROPORTIONAL CHART FOR CENTRIFUGAL FORCE

in the lengths c and d. An inspection of the diagram shows that

$$a - b = c - d,$$

or the difference between the lengths on the two axes cut by any system of parallel lines is constant. If the quantities on either axis had been laid off below the zero instead of above it we should have had a constant sum instead of a constant difference. We may even get a case corresponding to

$$a - b = c + d,$$

if we lay off the quantity d below the zero and the others above. This will be referred to later. As in the previous type of chart, there is no need to have the values a and c, or b and d laid off on the same axes. They may be laid off on parallel axes if the distance between each pair of axes is the same. This distance might be varied if the need for it arose, but it would require an alteration in the scale units to correspond.

To save referring to it again, it might as well be noted here, once for all, that this chart, and all of those yet to be described involving four variables, has the same rotational property as was indicated in Fig. 3 for the first type. This is shown in

Fig. 6, where the c and d axes have been turned through 90 degrees without altering their relative positions. The position of the index is shown by the fine lines, and the construction is sufficiently clear, I think, to render any further explanation unnecessary.

A chart of the kind we have been examining is of little importance if we are only to use it for addition and subtraction; but it acquires an added value if, instead of plotting the numbers themselves on the axes, we plot their logarithms. This transforms the chart into one for multiplication and division.

Plotting of a Chart from Formula for Centrifugal Force

An example of the use of it is given in Fig. 7. The formula used is that for centrifugal force,

$$C = \frac{w\,v^2}{g\,r},$$

where C is the centrifugal force in pounds, w is the weight in pounds, g is the acceleration of gravity, v is the velocity in feet per second, and r is the radius in feet of the path of the weight. Rewrite the equation

$$\frac{C}{w} = \frac{v^2}{g\,r}$$

Then

$$log.\ C - log.\ w = 2\ log.\ v - log.\ g\,r$$

which is identical with the fundamental equation given above. The limits between which we are to work are of no special importance here, since the chart is not supposed to be applied to any particular problem. We will have to fix some conditions, however, so let us say that w varies from 1 pound to 100 pounds, v from 1 foot to 50 feet, and r from 0.1 foot to 10 feet. The maximum value of C will be 776.4, and of its logarithm 2.89. The maximum value of $log.\ v^2$ is 3.398, of $log.\ w$ is 2, and of $log.\ 32.2\ r$ is 2.508.

In graduating the axes the same scale unit must be used throughout. All except the r-scale commence with mark 1 at the zero point, and are laid off in any convenient sized divisions from a table of logarithms. The C-scale was extended to 800 instead of stopping at its exact upper limit, 776.4. In the case of the r-scale we we must place mark 1 at a distance of 1.508 ($log.\ 32.2$) above the zero, and graduate above and below this as desired. Fig. 7 shows the completed diagram with transversals drawn to indicate a solution for $w = 30$, $v = 9$, and $r = 10$; C should then equal 7.55.

Plotting of a Chart from the Formula for Piston-rod Diameter

With this type of chart it is not necessary that the equation be in the form of a simple proportion, though it should be capable of being placed in that form by a little manipulation. For instance, take the formula given by Kent for the diameter of the piston rod of a steam engine,

$$d = 0.013\sqrt{D\,l\,p},$$

where d is the diameter of the rod, D is the piston diameter, and l the length of the stroke, all in inches, and p the maximum steam pressure in pounds per square inch. Squaring, this becomes

$$d^2 = 0.000169\,D\,l\,p = \frac{D\,l\,p}{5917}.$$

In its proportional form it is:

$$\frac{d^2}{D} = \frac{l}{\frac{5917}{p}},$$

or in logarithms,

$$2log.\ d - log.\ D = log.\ l - (log.\ 5917 - log.\ p),$$

which agrees with the fundamental equation for this type of chart.

Here we plot the logarithms of d^2, D and l as usual. In the case of p, however, we first lay off the $log.$ of 5917 (=3.772) from the zero and from that point plot the logarithms of p *downward*, since we use the reciprocal of p and not p itself in the last member of the proportion. For the sake of compactness it is well to have all four scales on about the same horizontal zone, and since those of l and p are much higher than the others we drop their zeros by equal distances below those of d and D. The zeros are not shown in the chart, Fig. 8, since none of the graduations go down that far, and only the working parts of the scales are needed. No error is introduced by this shifting of the scales since the slopes of the lines joining them are the same before and after the transfer. The units used in graduation must be the same for all scales unless a different one is indicated by the exponent of the quantity. Therefore, D, l and p are plotted with one unit, and d (since it is squared) with one twice as large. The resulting chart is shown in Fig. 8, and the broken parallel lines give the solution for the case where $D = 20$ inches, $l = 30$ inches, and $p = 100$ pounds. Then $d = 3.18$ inches.

It may be mentioned here that this type of chart may be applied to equations containing but three variables. If, for instance, in our equation

$$\frac{a}{b} = \frac{c}{d},$$

a, b and d are variables and c a constant, the c graduation is reduced to a single point through which all lines referring to c must pass. The method of using such a chart is precisely the same as for those just described, and it is hardly of sufficient importance to merit more than a passing notice.

The examples which have been given will illustrate sufficiently well, I think, the general methods to be followed in cases involving a simple proportion, and we will now proceed to examine a new type which, while it bears a family resemblance to those previously described, differs from them in several important particulars. So far our charts have allowed us to operate on the variables by simple addition, or simple multiplication, but have not permitted these operations to take place simultaneously—at least directly. The next

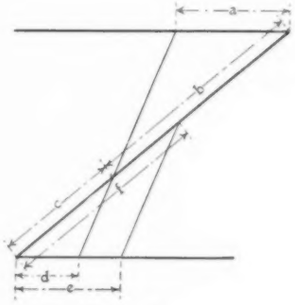


FIG. 9

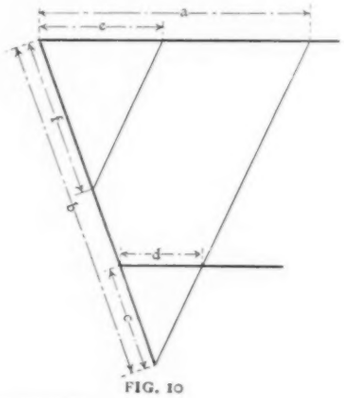


FIG. 10

DIAGRAMS ILLUSTRATING Z-CHARTS

chart to be examined possesses this valuable property, and is known as the Z-type of chart.

The Z-chart

In Fig. 9 we have three axes arranged in the form of a letter Z. Draw a transversal across them. From similar triangles we have

$$\frac{a}{d} = \frac{b}{c},\ \text{or}\ a = \frac{b\,d}{c}.$$

Add d to each side of the equation and we have

$$a + d = \frac{b\,d}{c} + d = \frac{d}{c}(b + c).$$

Now $(b + c)$, the length of the diagonal of the Z, is a constant which we may call k.

$$\therefore\ a + d = \frac{d}{c}k. \qquad (1)$$

Draw a second line parallel to the first transversal. Then

$$\frac{d}{c} = \frac{e}{f},$$

and the original equation becomes

$$a + d = \frac{e}{f} k. \qquad (2)$$

If then the equation which we are to chart has the form

$$u + v = \frac{x}{y},$$

we lay off u on the upper horizontal, v on the lower, x also on the lower and y on the diagonal. Joining the values of u and v corresponding to a and d by a transversal, and drawing a parallel to it through the value of x corresponding to e we get the resulting value of y, or f on the diagonal.

Similarly, we may get the solution of a problem where the difference of two quantities is used instead of their sum. Fig. 10 shows the arrangement. Here, as before,

$$\frac{a}{d} = \frac{b}{c} \text{ or } a = \frac{b\,d}{c},$$

and

$$a - d = \frac{b\,d}{c} - d = \frac{d}{c}(b - c) = \frac{d}{c} k$$

$$\therefore a - d = \frac{e}{f} k.$$

The selection of the scale units is of some importance with this chart and a brief discussion of their mutual relation is necessary. It is understood, of course, that the numerical values of the quantities u, v, x and y are to be multiplied by certain scale units in order to get their measured lengths a, d, e and f on the axes. Let these lengths be l_1, l_2, l_3 and l_4 for u, v, x and y, respectively. For u and v the scale unit must be the same ($l_1 = l_2$), since otherwise parallel lines joining their scales would not indicate a constant sum, but l_3 and l_4 may be chosen at will. Now since $a = l_1 u$, $d = l_1 v$, $e = l_3 x$ and $f = l_4 y$ we have by substitution in equation (2)

$$l_1(u + v) = \frac{l_3 x}{l_4 y}(b + c),$$

or since

$$u + v = \frac{x}{y},$$

$$l_1 = \frac{l_3}{l_4}(b + c)$$

and

$$(b + c) = \frac{l_1 l_4}{l_3}, \qquad (3)$$

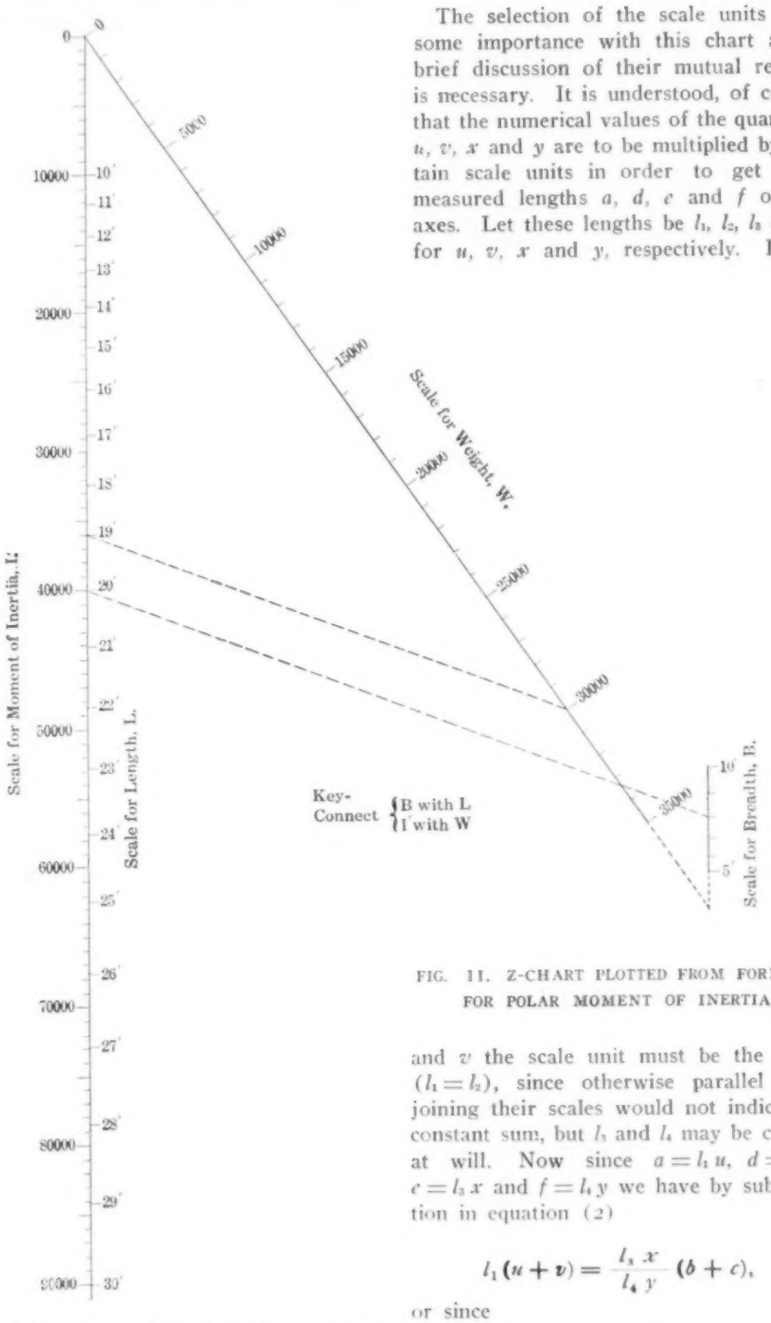


FIG. 11. Z-CHART PLOTTED FROM FORMULA FOR POLAR MOMENT OF INERTIA

which gives the necessary length of the diagonal of the Z.

For the subtraction formula this becomes

$$(b - c) = \frac{l_1 l_4}{l_3}. \qquad (4)$$

Sometimes we wish to make $l_3 = l_4$. In this case

$$(b + c) = l_4, \qquad (5)$$

or the diagonal is the same length as the scale unit used in graduating it.

It should be noted here that the a and d scales may be shifted along their axes in the *same* direction as far as we please, without changing the direction of the transversal joining them and that, therefore, no error will be introduced. This sometimes permits us to make a more convenient arrangement of the scales as will be shown later in connection with the chart for chimney draft.

Plotting of a Chart from the Formula for Polar Moment of Inertia

As the first illustration for the construction of the Z-chart I have chosen the formula for the polar moment of inertia of a flat rectangular plate about an axis perpendicular to its plane and passing through the center. It is used in the power calculations for the draw spans of bridges, the assumption being that the span may be taken as approximately the equivalent of the flat plate. The formula is:

$$I = \frac{W}{12}(B^2 + L^2),$$

where I is the polar moment of inertia, W the weight of the plate, and B and L its breadth and length. The weight will be expressed in pounds and B and L in feet. The engineer who wishes to have the forces in his final results in pounds instead of poundals, will usually prefer to divide at once by g, instead of doing this at the end of his calculations; in which case the formula becomes

$$I^1 = \frac{W}{386.4}(B^2 + L^2).$$

This may be written

$$\frac{I^1}{\frac{W}{386.4}} = (B^2 + L^2),$$

and we evidently have an equation suited to the Z-type of chart.

When planning this chart my intention was to give it something like a practical form by taking the maximum values of B and L as about 10 and 80. However, since these quantities are to be squared and $L^2 = 6400$, while B^2 is only 100, it is evident that if we lay them off to the same scale and use any practicable length for 6400, 100 would be so small (after the necessary reduction by the engraver) that its subdivisions for smaller values of B would be illegible in the cut. In view of the fact, however, that the charts which

accompany these articles are intended primarily as illustrations of methods of construction and application, I have not hesitated in many cases to sacrifice a practical chart for the sake of getting one which showed a process clearly, and this I shall do in the present instance. The conditions are assumed to give clear reading scales in the cut, but the chart in its present form will have no practical value for the bridge designer.

Let us say then that the maximum value for W is to be 35,000, that the maximum value for B is 10 feet, and for L, 30 feet. Then the maximum value for I^1 is very nearly 90,000. The scale units and scale lengths must next be fixed. I wished to keep the original drawing inside of a length of 10 inches. By making the scale unit for I^1 $\frac{1}{10000}$ I get a graduated length of

$$90{,}000 \times \tfrac{1}{10000} = 9 \text{ inches.}$$

This is the scale unit we called l_3 in the preliminary explanation. For the W-line it will be convenient to make the scale unit, l_4, equal to $\frac{386.4}{5000}$. Then

$$\frac{35{,}000}{386.4} \times \frac{386.4}{5000} = 7 \text{ inches}$$

is the graduated length of this axis. This unit makes it possible to plot W directly from the 50 side of an engineer's scale without bothering about the coefficient $\frac{1}{386.4}$. For the L and B scales let us take $l_1 = 1/100$. Then for L^2 we have a graduated length of $900 \times 1/100 = 9$ inches, the same as for I^1, and for B^2 $100 \times 1/100 = 1$ inch. Substituting the scale units thus found in equation (3) we get for the length of the diagonal of the Z_1

$$(b + c) = \frac{l_1 l_4}{l_3} = \frac{\frac{1}{100} \times \frac{386.4}{5000}}{\frac{1}{10000}} = \frac{3{,}864{,}000}{500{,}000} = 7.728 \text{ inches.}$$

Having drawn our axes (the diagonal making any convenient angle with the parallels) we have only to graduate them, and this is a simple matter, B and L being plotted in the squares of the desired values with a scale unit of 1/100, while the W- and I^1-lines are plotted directly from the $\frac{1}{10000}$ and $\frac{1}{100000}$ scales. The parallel broken lines show how the chart is read for the case where $B = 8$, $L = 20$, $W = 30{,}000$, which gives for I 36,000.

Plotting of a Chart from the Formula for Intensity of Chimney Draft

The next formula which I have charted is one for the intensity of chimney draft

$$f = h\left(\frac{7.64}{T_2} - \frac{7.95}{T_1}\right),$$

where f is the draft expressed in inches of water, h the hight of the chimney in feet, T_1 the absolute temperature of the chimney gases and T_2 the absolute temperature of the external air.

The formula will be seen at once to belong to the second type of Z-chart where we have a difference instead of a sum of two variables. The general method of procedure is identical with that just described but there are a few differences of minor detail which require a brief description. Thus the variables T_1 and T_2 appear in the denominators of the fractions instead of the numerators, which indicates that the plotted values are proportional to the reciprocals of these quantities and not to the quantities themselves. For our limits let us take h as varying between 50 and 150 feet, T_1 from 761 to 1161 degrees absolute (or from 300 degrees Fahrenheit to 700 degrees Fahrenheit) and T_2 from 461 to 561 degrees absolute (or from 0 degrees Fahrenheit to 100 degrees Fahrenheit). Then f will

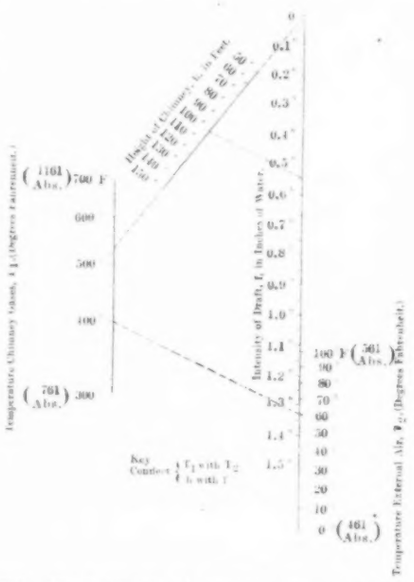

Temperature Chimney Gases, T_1 (Degrees Fahrenheit)
Height of Chimney, h, in Feet
Intensity of Draft, f, in Inches of Water
Temperature External Air, T_2 (Degrees Fahrenheit)
Key
Condition: $\frac{1}{T_1}$ with T_2
$\frac{1}{h}$ with f

FIG. 12. Z-CHART TO DETERMINE INTENSITY OF CHIMNEY DRAFT

have a maximum value of 1.46 inches and we will graduate it from 0 to 1.5 inches. The scale unit on the f-line (l_3) I took as $\frac{1}{0.2}$ which gives a length of $1.5 \times \frac{1}{0.2} = 7.5$ inches for its graduations; l_4, the h-scale unit was taken as 1/40. This gave a graduated length from zero of $150 \times 1/40 = 3.75$ inches; l_1, the unit used for T_1 and T_2 was made 1/0.001. The extreme length of the T_2-line from its zero will then be

$$\frac{7.64}{461} \times \frac{1}{0.001} = 16.6 \text{ inches,}$$

too great for the size of chart planned which I wished to keep within a length of 10 inches. The lower limit of the graduations on this line is

$$\frac{7.64}{561} \times \frac{1}{0.001} = 13.62 \text{ inches}$$

from the zero. This is an empty space which is of no advantage, and the chart will be improved in appearance and compactness if we slip the graduations along the axis toward the zero point or the point where the diagonal intersects this axis. In my drawing the graduations were shifted a distance of 8 inches which brought them within the prescribed limits. The T_1-graduations were shifted the same amount in the same direction and thus no change was made in the direction of the transversals joining them and no error introduced.

The length of the diagonal, from equation (4) is

$$(b - c) = \frac{l_1 l_4}{l_3} = \frac{\frac{1}{0.001} \times \frac{1}{40}}{\frac{1}{0.2}} = \frac{0.2}{0.04} = 5 \text{ inches.}$$

As many values of $\frac{764}{T_2}$ and $\frac{7.95}{T_1}$ as are wanted are now calculated and plotted remembering that their zeros are 8 inches beyond the points where the diagonal intersects their axes, h is plotted on the diagonal and f on the same axis with T_2.

In lettering the T_1- and T_2-lines it will be a convenience for the person who uses the chart to have the temperatures marked in the Fahrenheit scale instead of from the absolute zero. This has been done on the chart, but the absolute temperatures have been retained at each end of the scales as an aid to a clearer understanding of the construction. The position of the parallel index lines shows the application of the chart to the case where the chimney temperature is 400 degrees Fahrenheit, the temperature of the outside air 60 degrees Fahrenheit, and the hight of the chimney 100 feet. The draft gage reading should then be a trifle over 0.54 inch.

Plotting of Chart from Formula for Safe Load on Hollow Cast-iron Columns

An interesting application of the Z-type of chart is to certain equations where a variable appears twice. Since each time it appears it occupies a scale, the number of variables we can handle is reduced from four to three. Suppose the fundamental equation to be of the form

$$u + v = \frac{v}{y}.$$

This evidently refers to equation (1) used in demonstrating the Z-chart. Here one index line instead of two is used in making a reading.

This gives a particularly useful chart since equations of this type are by no means uncommon and are awkward things to handle by any of the methods hitherto described. A formula which will serve as an excellent illustration is the one given below which is taken from the "Cambria" pocket-book:

$$P = \frac{5}{1 + \frac{L^2}{800\,D^2}}.$$

It is the formula for the safe load on hollow round cast-iron columns with square ends. In it P = the safe load in tons (of 2000 pounds) per square inch of column section, D is the outside diameter of the column in inches and L the length of the column also in inches. The successive steps required to put the formula into working shape are indicated below

$$1 + \frac{L^2}{800\,D^2} = \frac{5}{P}$$

and

$$800\,D^2 + L^2 = \frac{800\,D^2}{0.2\,P}$$

Let us take the limits for D as 6 and 15 inches, for L as 72 inches (= 6 feet), and 288 inches (= 24 feet). Then P will vary between 1.3 tons and 4.86 tons. The maximum value to be laid off on the L — line will be $\overline{288}^2$ or 82,944, on the D-line $800 \times \overline{15}^2 = 180{,}000$, and on P, $0.2 \times 4.86 = 0.972$. The scale units for L and D being the same, it is evident that the value 180,000 will control the choice of the scale unit if we are planning a chart of a certain size. Suppose the scale unit l_1 is made $\frac{1}{20000}$. Then

$$180{,}000 \times \tfrac{1}{20000} = 9 \text{ inches},$$

which is about right. For L we have

$$82{,}944 \times \tfrac{1}{20000} = 4.147 \text{ inches}.$$

The scale unit l_1 used in graduating P on the diagonal will be taken as $\frac{1}{0.1}$ and the graduated length will, therefore, be

$$0.972 \times \tfrac{1}{0.1} = 9.72 \text{ inches}$$

Since $l_3 = l_1$ the length of the diagonal intercepted between the parallel axes is, according to equation (5), l_4 or $\frac{1}{0.1} = 10$ inches. On the chart, Fig. 13, D^2 has been graduated for every inch between 6 and 15 inches, and from its zero the diagonal, 10 inches long, has been drawn in any convenient direction. On it we may consider that we are graduating $0.2\,P$ with a scale unit of $\frac{1}{0.1}$ or P with a scale unit of $\frac{1}{0.5}$. Lastly the second parallel is drawn from the end of the diagonal and graduated for L^2. This has been done for every 12 inches and the points marked with the corresponding values in feet.

As noted above, but a single transversal or index line is required for reading this chart.

By joining 15 feet on the L-line with 10 inches on the D-line we find the safe load per square inch on the column is 3.56 tons.

Before leaving this subject it might be well to call attention to the fact that another way of treating three variables by the Z-chart is to imagine that one of the four which normally belong to it is replaced by a constant. The scale belonging to it then reduces to a point through which all of the lines pertaining to it must pass.

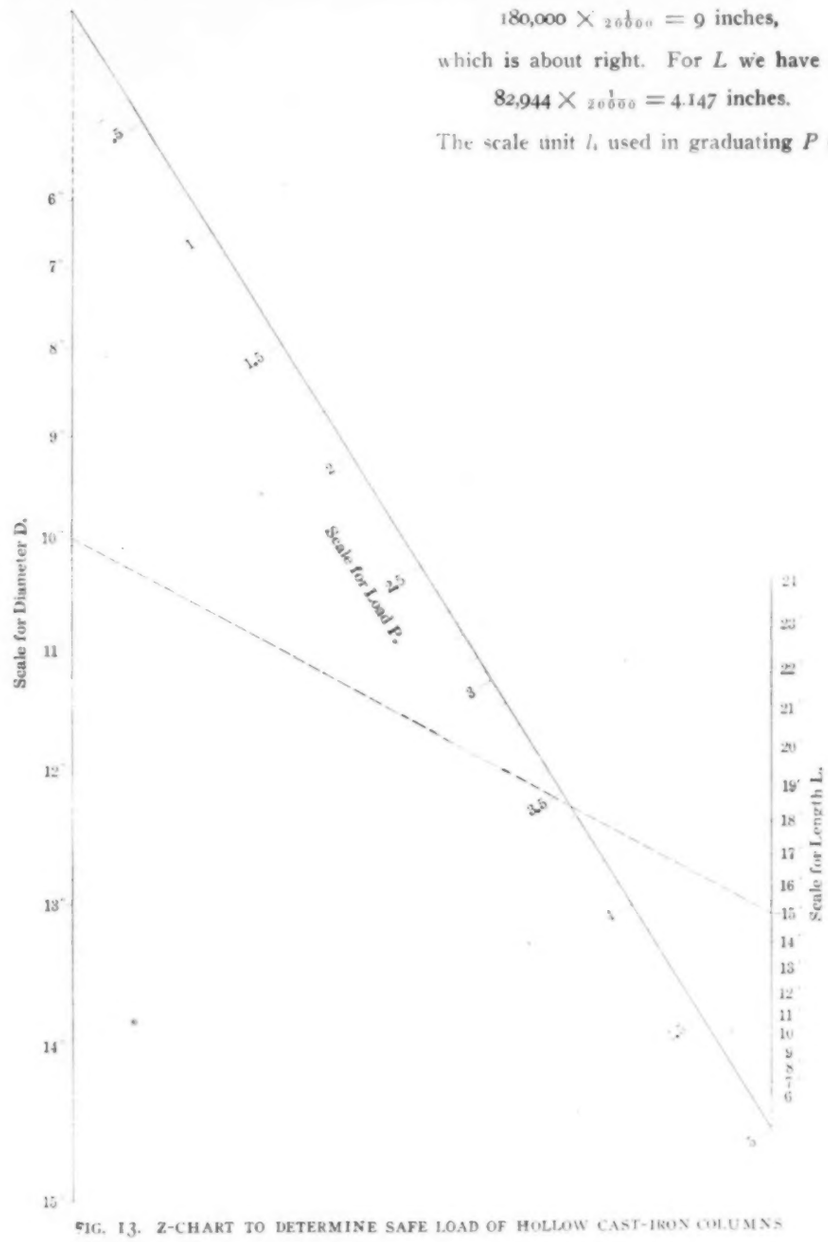
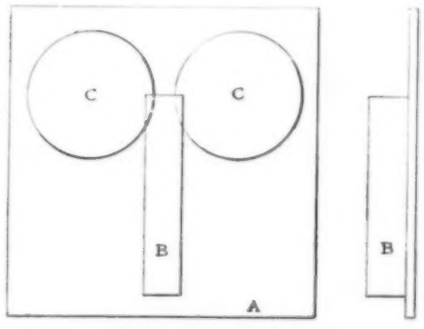


FIG. 13. Z-CHART TO DETERMINE SAFE LOAD OF HOLLOW CAST-IRON COLUMNS

A Cheap Way of Making a Fly Cutter

By Roy Burt

I have been much interested in the articles on the master plate which have recently appeared in the American Machinist. Having some gears to cut (a rough job) and not wishing to go to the expense of regular cutters, I made fly cutters for them. After laying out the curves to a large scale and finding approximate radii, the centers were laid out on sheet tin the proper distance apart and to full size. The piece of steel was then soldered to the plate in the proper position and the whole clamped to the face plate, centered for one of the sides, and bored to the radius laid out. The other circle was then centered and the other side bored to size. This finished the cutter. The sketch shows the idea; A being the sheet tin, B the tool blank and $C\,C$ the circles laid out for the tooth curves. There are many uses for the master plate, locating centers, which either are not on, or are not easily located on the piece itself for rough, as well as accurate work.



MAKING A FLYCUTTER

An Extensive Use of Baked Molds

Smooth-finished, Cast-iron Steam Drying Cells Are Made Successfully in Baked Molds by the Cell Drier Machine Company

EDITORIAL CORRESPONDENCE

The Cell Drier Machine Company, of Taunton, Mass., manufactures steam-heated cloth- and yarn-drying machines known as cell driers. Each machine is built up of a large number of units, or sections, called cells. In reality each section is a large cast-iron steam radiator, having curved surfaces over which the cloth runs, provided with an inlet and outlet for the circulation of steam and with the interior baffled into three longitudinal sections. As the surface over which the cloth runs must be smooth, accurate to shape, and of a uniform density of metal, the best of foundry work is required.

Considerable experimenting has been done to develop the foundry methods, and the accompanying illustrations show the processes used in making a mold and core for one of these radiator sections or cells. Turning to the illustrations Fig. 1 shows a finished casting. The curved surfaces over which the cloth run will be noticed.

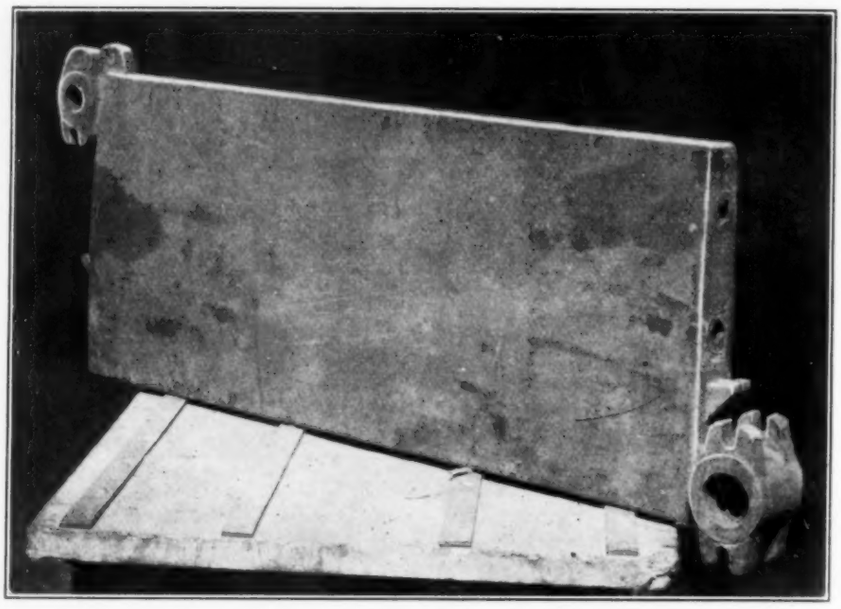


FIG. 1. A CELL-DRIER SECTION

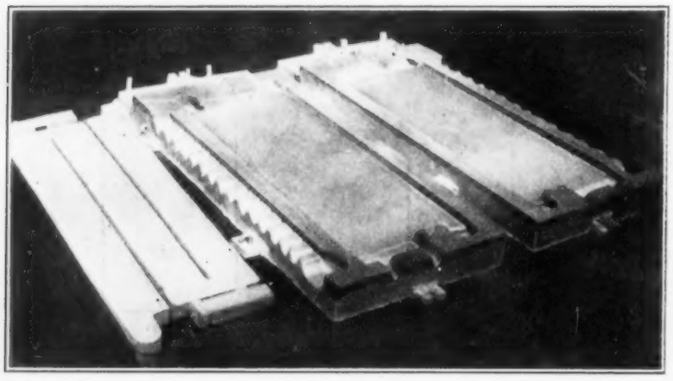


FIG. 2. A BAKED MOLD AND CORE

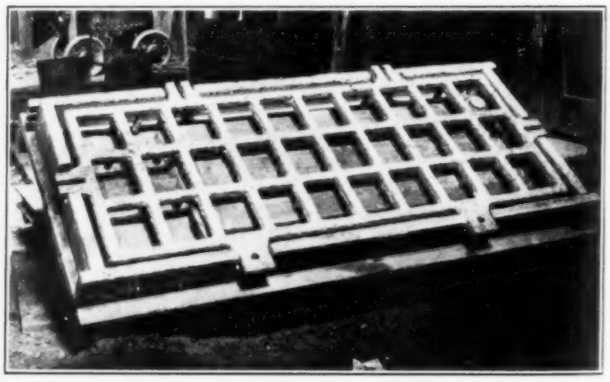


FIG. 3. MOLD ARBOR AND BOARD

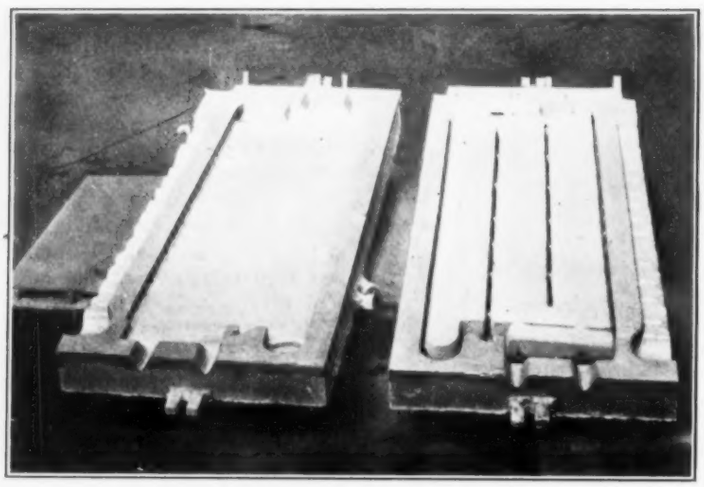


FIG. 4. A MOLD READY FOR CLOSING

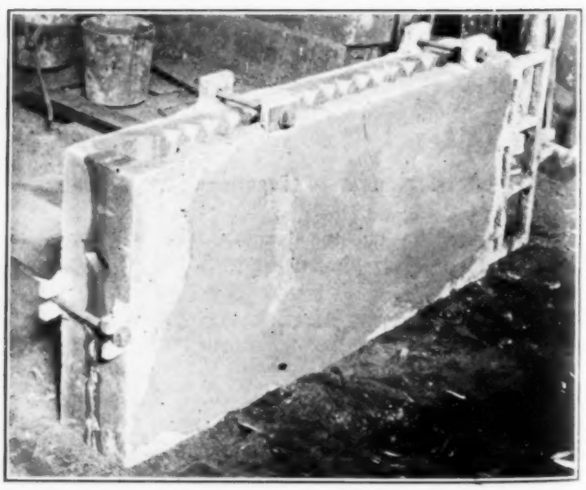


FIG. 5. A MOLD READY TO POUR

The two important features of the foundry work are the use of baked molds and the pouring of the mold on edge. Fig. 2 shows a finished baked mold open, and the baked core. Fig. 3 shows the mold board and arbor for one-half of a baked mold. The mold boards and arbors are so arranged that various lengths of castings can be molded as orders may require. Turning to Fig. 4 we see an opened finished mold with the cores in position, and Fig. 5 shows a mold closed for pouring and standing on edge in the position in which it is poured.

These cells are poured by the pencil or drop-gate method and by having the pouring basin made in the same core as the cell, the mold is ready to pour as soon as it is bolted together and turned on edge. The skeleton core arbors used in molding the cell shown in cuts were made for a cell 12 inches longer, which accounts for the arbor projecting beyond the core at one end. This demonstrates one way in which castings of this character may be made successfully with a temporary or makeshift rigging, when time is limited on the job and it is desired not to tie up a large amount of money in expensive iron flasks and other equipment.

A large core oven is naturally a part of a foundry equipment when handling this class of work. A view of this oven is shown in Fig. 6, in which it can be seen containing three trucks carrying cores and cell molds. An interesting feature of this oven is the rolling steel door for closing the entrance. It has often been stated that such doors will warp with the heat so as to become useless. A considerable experience with the door illustrated has demonstrated that it is perfectly satisfactory for the purpose. Its advantages over heavy, cumbersome swinging doors are too apparent to need mention.

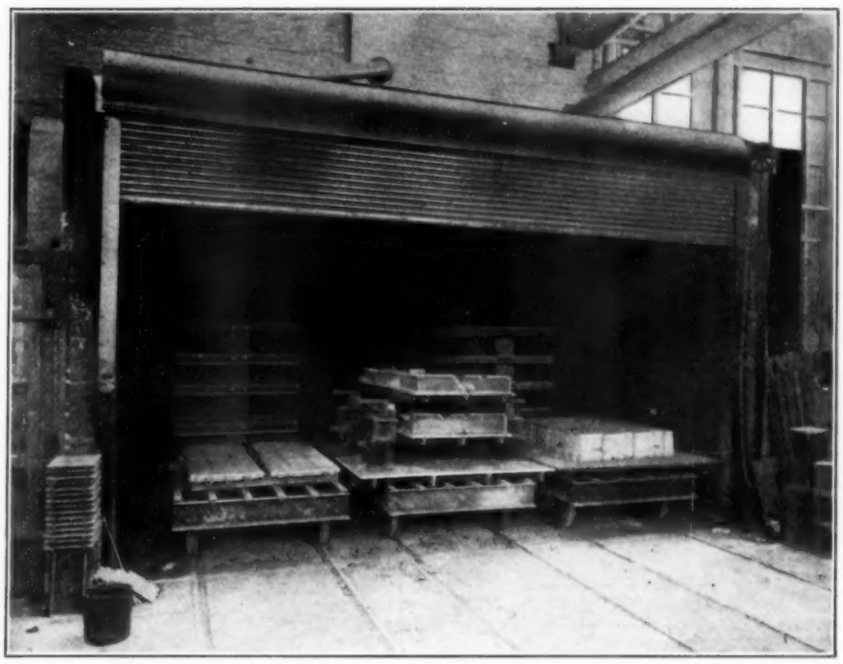


FIG. 6. A CORE OVEN WITH A ROLLING STEEL DOOR

The last illustration, Fig. 7, shows an interior view of the machine shop of the Cell Drier Machine Company with a cell drier stack in course of erection. An interesting feature of this building is the floor. This is composed of concrete into which square floor plates are set at intervals so that they are flush with the floor level. These plates contain T-slots and are of service in bolting down portable machine tools or for holding machinery during processes of machining and erection. A finished cell-drier section can be seen hanging from the traveling crane.

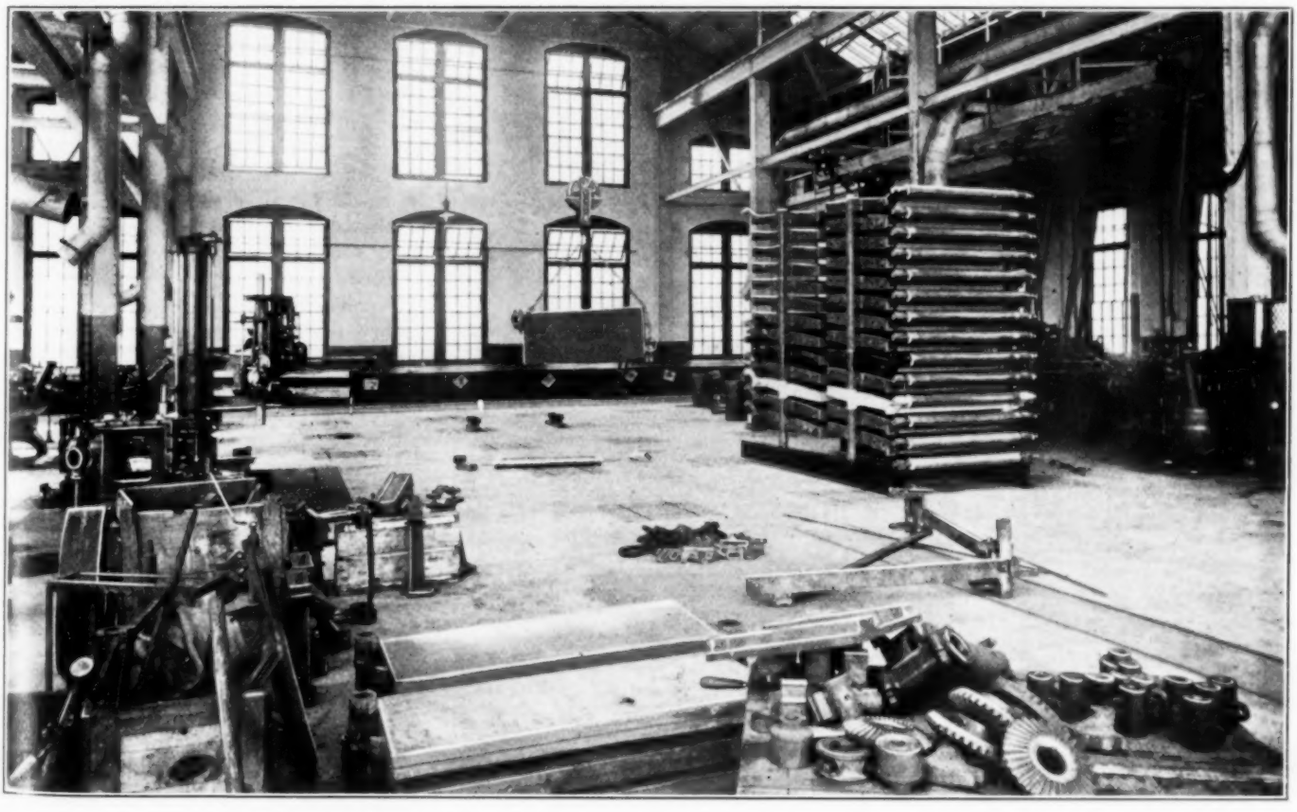


FIG. 7. A DRIER IN PROCESS OF ERECTION, AND A FLOOR-PLATE SYSTEM

A Wide-range Cam Cutter

EDITORIAL CORRESPONDENCE

A cam cutter of unusually wide range and adaptability is a recent product of the Garvin Machine Company, of New York City. It is well illustrated by the half-tones, Figs. 1 and 2.

Turning to Fig. 1 it is seen that the elements of the machine are simple. A base supports two uprights that carry the table and the cross-rail. The table carries the leader, work and feeding mechanism. The cross-rail carries a long slide upon which are mounted the cutter spindle and the pilot. This machine can cut any type of cam from 3 inches to 36 inches in diameter, whether a face, edge, disk, or cylinder cam.

THE TABLE

Referring to Fig. 1 the table carries two large worm wheels supported in vertical bearings. Both of these wheels are driven from the same shaft by means of worms. When cutting disk cams the leader is bolted to one of these worm wheels and the cam blank to the other. The arrangement is shown clearly by the half-tone illustration.

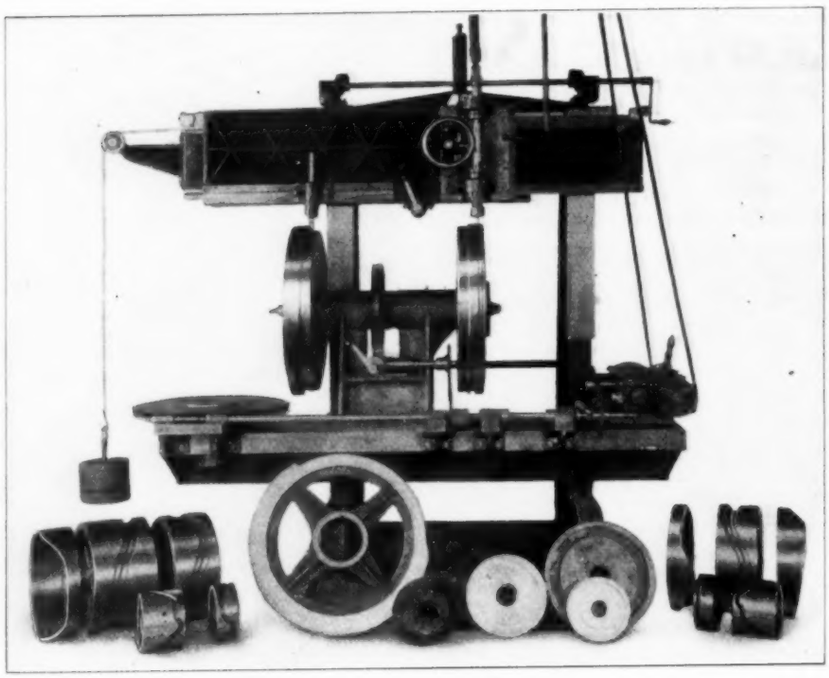


FIG. 2. CAM CUTTER CUTTING A BARREL CAM

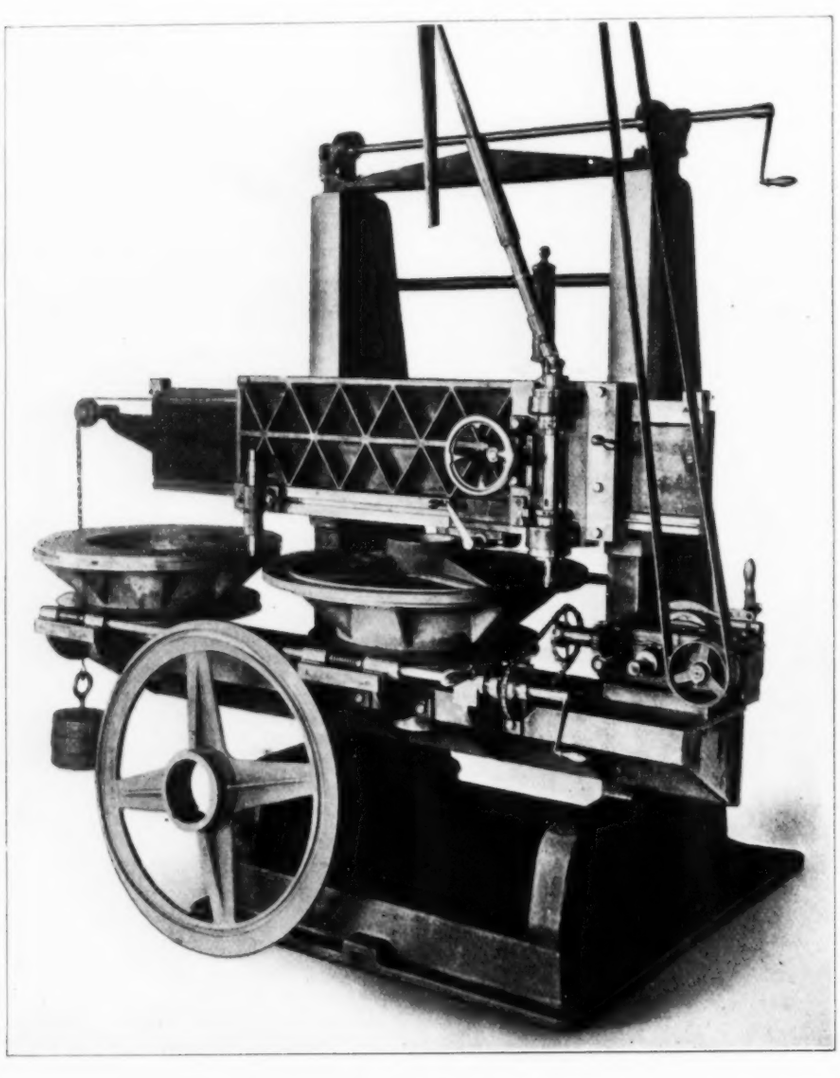


FIG. 1. CAM CUTTER CUTTING A FACE CAM

At the extreme right-hand end of the table is the feed box. This is a geared box similar to the one used on Garvin Nos. 14 and 15 vertical spindle milling machines. It is driven by a belt directly from the countershaft, and as there are three countershaft cone steps, there are three primary speeds for the box. For each primary speed there are 10 instantaneous changes, making a total of 30 changes of feed for the machine. The control is by means of two levers and a knob. All the gears run in a bath of oil. Motion is transmitted from this gear box to the leader and cam-blank driving shaft by means of a worm wheel, sprockets and chain. These details show in the first half-tone illustration.

Fig. 2 shows the machine set up for cutting barrel or cylindrical cams. The method of driving the leader and blank, and the feeding mechanism are so clearly shown that description is unnecessary.

THE CROSS-RAIL

The cross-rail is carried on the front of the housings and is under the control of elevating screws that run on ball bearings. The method of mounting the slide on this cross-rail is especially noteworthy. The upper horizontal surface of the rail has a V-groove carrying a long row of balls. The opposing surface of the slide has a similar groove which fits over this row of balls. At the lower edges of slide and rail are two opposed, inclined surfaces between which is another row of balls. Suitable adjustments and takeups are provided, so that the slide travels back and

forth on the balls. The friction of the slide on the rail is very little. A counterweight for the slide is shown at the left-hand end of the machine. This counterweight can be placed on the other end of the machine if desired.

The cutter spindle is mounted on a vertical bearing plate in the cross-rail slide. A hand-wheel is provided for vertical adjustment in setting the cutter, and a clamping screw can be seen at the right of the spindle, so arranged that the spindle-bearing plate can be locked in position after the cutter is properly set. Directly above the hand-wheel can be seen a cylindrical case surrounding a counter-balancing spring for the cutter spindle-bearing plate. The spindle is driven by a telescoping universal joint shaft from the countershaft overhead. There are three countershaft speeds, and, therefore, three spindle speeds, each one of which corresponds with 10 of the changes of feed that have been mentioned.

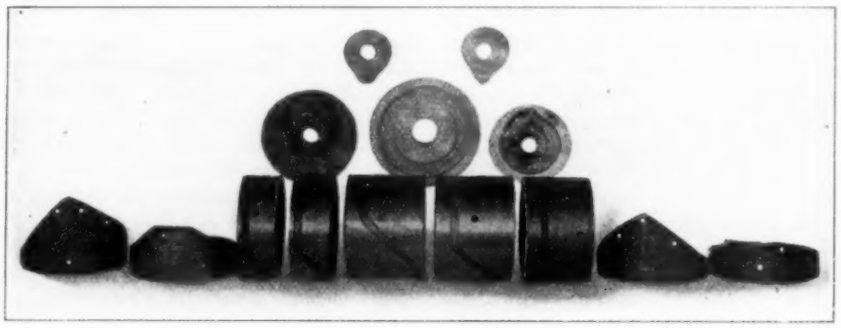


FIG. 3. A GROUP OF CAMS AND LEADERS

A stop is provided for the movement of the slide on the cross-rail and another stop for the vertical movement of the spindle-bearing plate on the slide. Thus it is possible to bring both rail and cutter spindle to predetermined positions when changing cam blanks, or for any other reason.

Directly below the hand-wheel is a handle connecting with a gear that meshes with a rack on the cross-rail. This is used for longitudinal adjustment of the cross-rail slide when setting up.

Along the lower left-hand edge of the slide is a finished T-slot, in which the pilot pin, or pilot-roll stud is clamped.

Leaders

Fig. 3 shows in the central part a group of cams that were cut on this machine. Two leaders for face cams are shown in the upper central part. They are very simple and inexpensive to make. They are made from sheet steel about ⅛ inch thick. Four leaders for cylindrical cams are shown in the front row of Fig. 3, two on each end. They are also made from ⅛-inch sheet steel bent and formed to shape. When used they are screwed and doweled to master hubs or barrels and thus form the leader.

Fig. 4 shows the cam cutter, cutting a long barrel cam with several cam grooves. The built-up leader can be seen plainly.

It is possible to cut cams of the same, larger or smaller diameter than the leader by changing the center distance of pilot and leader, and cutter and blank as desired. The feed box has a reversing mechanism, so that a leader can be rotated in either direction, selecting the one which presents the easier angles for the pilot and cutter to climb.

Circular Milling

It is obvious that if the slide is clamped in a given position on the cross-rail that the machine is adapted for circular milling. Such circular milling can be done either on the face or periphery of a cylinder, and the range of the machine is as wide for this class of work as for cam cutting.

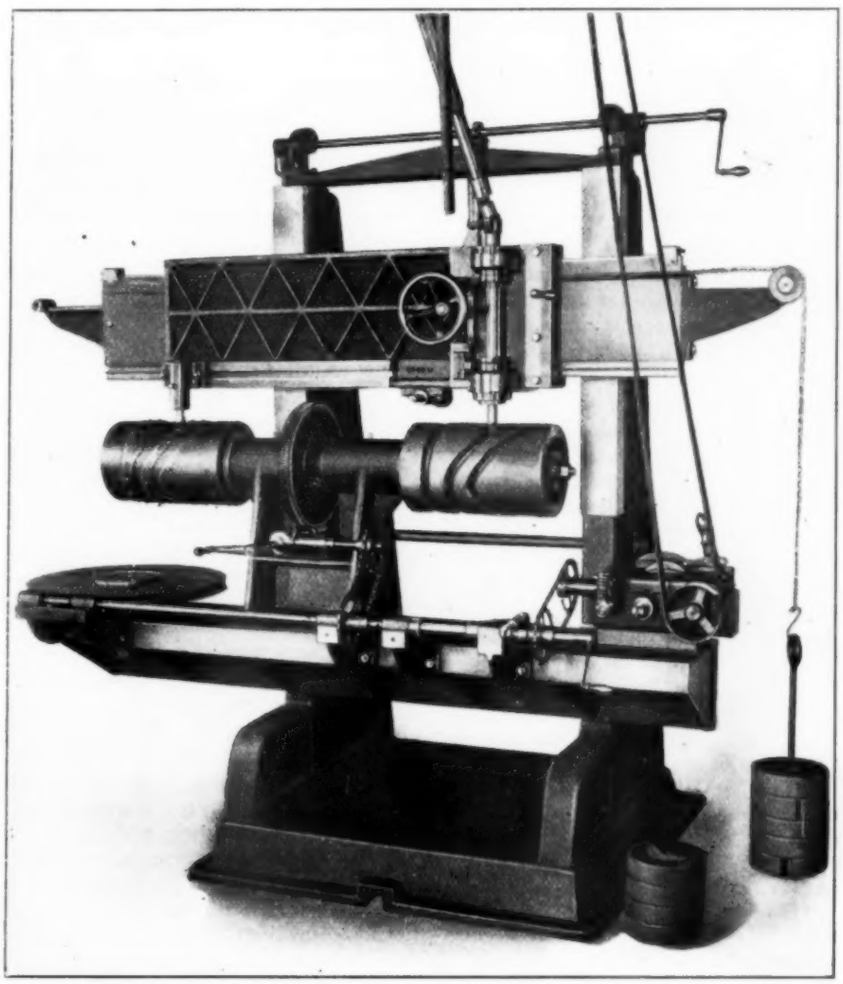


FIG. 4. CAM CUTTER CUTTING A LARGE BARREL CAM FROM A BUILT-UP LEADER

The most serious objection to the common gas mantle has been its extreme fragile composition which rendered it so easily broken. It is now reported that as a result of extended experiments made by German chemists a mantle has been produced that will be of a much more durable nature, and capable of resisting a great amount of shock and usage without breaking. Many efforts have been made to bring about this result by the use of tough natural fibers, but such attempts have been unsuccessful. The new material is an artificial silk made by dissolving cellulose in ammoniate of copper.

Some scientists are wrangling over the question whether plants think. If the question applies to our industrial plants that are running on 50 per cent. or less of their capacity, it is certain that if these plants do not think, their stockholders do, especially about the time that the directors vote on dividends.—*Ideal Power.*

Machine Tool Industry in Continental Europe

A Review of the Reports of the Special Investigations Conducted by the Department of Commerce and Labor During the Past Six Months *

BY CAPT. G. L. CARDEN†

Until the present year there has been no special agent in the field reporting solely on the machine-tool situation. Other interests represented comprise the manufacturers of agricultural implements, the cotton manufacturers, the milling interests and the cotton-seed oil manufacturers. The appropriation for the present fiscal year is less by $10,000 than it was for the previous fiscal year, and it will be recognized that the extent to which these investigations can be carried on, the number of men who can be put into the field, and the diversity of interests which can be represented is largely a matter of appropriation.

I mention these facts because, in a recent address of the Secretary of the Department of Commerce and Labor, the necessity of a closer working agreement between the department and the manufacturers, generally, was emphasized. The department has labored to bring about not only a national congress of manufacturing interests, but the existence of a national advisory committee at the capital. In the lists of manufacturing associations represented at the last national congress I fail to find the name of the National Machine Tool Builders' Association.

America's Enviable Position

In the manufacture of high-grade machine tools, America, in the past decade and a half, has easily led the world. We have enjoyed the benefits of an enormous territory in which our facilities have hardly been equal to the demand. Under existing conditions we have not felt foreign competition, and the result has been that many of our manufacturers have been enabled to specialize and by that I mean they have been able to confine their efforts to the manufacture of a very limited number of designs of tools, and in some cases, as you all know, American manufacturers have confined themselves to one tool design, and even to one size of that design. Under such conditions it has been possible to give one's whole attention, thought and energy to the development of a special tool, and it is not to be wondered at that the superlative has been attained in the building of certain special machines under such conditions.

As the antithesis I recall asking a prominent French machine-tool manufacturer recently how many different designs of tools he manufactured, and he replied, "152." "Ah," he added, "if our territory was not restricted perhaps we too could specialize, and if we could but specialize as do you Americans, it ought not to be impossible for us to gain a like amount of knowledge, but we have not a sufficient territory and, in order to keep our shops going, it is necessary to take almost every order that comes along. For this purpose we must keep a vast quantity of patterns on hand." There are but few shops specializing in Europe in the American sense of the term. I have in mind now, one firm which is confining its attention largely to lathes, and it is able to do this by reason of having practically a subsidy from its government in the shape of constant orders for government equipment.

Germany's Industrial Activity

But the country which concerns our American manufacturers more than any other is Germany. Owing to enormous demands at home, our American manufacturers have not been able to give that close attention to the foreign field which they might otherwise have done, had conditions here been unfavorable. There are American firms which *do know* and appreciate the foreign situation, but my own observation impels me to believe that the majority of our manufacturers have either an erroneous or inadequate knowledge of the foreign field. In consequence of this, they have not given the German in particular, credit for learning and developing. Many of our manufacturers do not know what has become of their tools beyond Sandy Hook; they do not know where their tools are placed abroad, and many are unable to say what prices have been charged by the agents. I mention this as illustrating the apparent helplessness of many of our firms in the matter of their selling connections.

In the year 1907 the German machine-tool manufacturers imported 9106 complete machine tools. Of this number about 70 per cent. came from America. During the same year, 1907, German machine-tool manufacturers exported 52,553 complete machine tools and covered 23 foreign countries in these sales. In point of weight almost as much more, in the shape of accessories and spare parts was exported by the German manufacturers in the same period as in the machine tools themselves. Of all the countries covered by the German exporters, Italy was the heaviest purchaser, and in my opinion, Italy, of all European countries, is more ready to buy American machine tools than any other. Bear in mind the figures of 52,000 and more machine tools exported by German manufacturers in the last year, and it must be evident that there is a demand for tools somewhere outside of our own country.

Broadly speaking, the American machine tool excels, both in design, workmanship and accuracy with which it works, the foreign-built tool. Size-for-size the American medium-class machine tool brings more money than does the foreign-built article. A German machine tool which sells for about 8000 marks ($2000) represents the same size and class American tool which brings abroad 10,000 marks ($2500).

American machine tools are bought abroad as a rule because of superior merit. The moment a foreign tool approximates in point of accuracy to an American machine tool, the foreigner will buy the product of his own country; this is natural and to be expected. The foreign buyer has been educated up to a point where he expects to pay more for an American machine tool than for a European-built one.

German Technical Education

It is technical education which is placing Germany where she is today in the manufacturing field. Germany probably leads the world in economics and in economical attachments and devices. At one technical institution for learning, Charlottenberg, they are graduating no less than 1800 young men every year; they are maintaining a student force there of between 4000 and 5000, and not only Charlottenberg, but Leipzic, Munich, Hanover and Dresden and Dantzig, and many other technical colleges are carrying on a similar work, and these young men as fast as they are graduated, carrying with them the highest degree of engineering education, are absorbed by the great iron and steel and machinery plants, and they are the men who are making Germany what she is in the world today. If the German machine-tool builders were only able to specialize as do many of our own, I would predict that it would not be long before they were abreast of our designers.

We excel the foreigner, whenever we do excel him, by reason of superior technical knowledge. This is the crux of the whole situation, and it is sheer madness for any American firm which proposes to hold its own in foreign competition to ignore technical education.

*Condensed from an address before the National Machine Tool Builders' Association.

†Of the United States Revenue Service, detailed for duty as special agent for the investigation of the European machine-tool trade possibilities, under the direction of the Department of Commerce and Labor.

Increasing Excellence of German Products

Fifteen years ago one might have traveled the length of the Rhine territory, which is one of the great manufacturing districts of Germany, and everywhere, I am told, one would have found English tools; today all this is changed; there is only one English house so far as I was able to observe, which is really doing a serious business in Germany and such English tools as are in service in German shops date their origin from purchase of years gone by.

There are a great many machine-tool firms in Germany. Many are mediocre, others are doing good work, while there are a few which may be classed as really dangerous competitors of the best American machine-tool firms. If any American manufacturer doubts this statement I invite his attention to the Chemnitz district, and in particular to the establishments of J. E. Reinecker, Wanderer Works, Schubert & Salzer, and Werkzeugmaschinenfabrik Union. I have not mentioned here the Loewe Works, the shops in Carlsruhe or in Grefenstaden or in Mulhouse, or in other noteworthy places, all of which are relatively doing as good work. It matters not whether all or any one of these firms can actually be accused of copying American machines; the fact remains that the work turned out by these German establishments so closely approximates to standard American work as to make it very difficult for the general run of buyers to detect any difference.

It is apparent, however, that during the last two years some of our manufacturers have neglected the foreign trade, and that we have not been as careful in matters of deliveries as the business warranted. One of the leading commercial men of all Prussia said to me in the course of conversation that he verily believed that the German tool builders had been able to profit during the last year by the failure of American firms to make good their representations regarding deliveries of the past two years.

Trend of Wages

There appears to be a tendency to advance wages among the better class of the German shops, especially in and around Berlin; the Chemnitz district pays less in wages, I believe, than any other part of Germany. At the Loewe works the wages for good tool men vary from 85 pfennig to 1 mark 20 pfennig an hour—a mark is about 24 cents. There are 100 pfennigs in a mark.

On the whole, however, they do not yet understand in a great majority of German shops, how to operate the greatest number of tools with the least number of men; this calls for the highest degree of intelligence and skill, such as found today in a most enhanced form in our best American shops. As I remarked before, however, we have not been giving the German credit for learning in the same line, but he is learning and he is learning fast, and if we propose to keep ahead in shop efficiency, we must look to the training of our workmen from boyhood up. In this connection I cannot refrain from calling attention to the high state of discipline in the German plants, and for this fine discipline the Germans have really to thank their military system. It is the German army of today which is the great institution of learning for the mass of the German people, and to thoroughly understand and appreciate German economical development, the German army must be reckoned with.

Influence of German-army Training

And what does the German army teach? It teaches at the outset cleanliness, the proper care of the body, the use and development of physical strength; it teaches order and economy, self-respect and honesty, and above all, it teaches discipline.

And what is the result? The soldier leaves the army with a developed capacity for work. Many a country boy never knew what he had in him until it was brought out by that greatest of all German institutions for learning—the army.

Ask the German manufacturer today what class of men, if any, makes the best workmen for his shop, and almost invariably the reply will be "the men from the army."

The Germans are rapidly acquiring technical knowledge and already they have an extraordinarily fine shop organization; they have everything but territory, and with territory, the ability to specialize. Their country is too restricted to make it possible for a new firm to hope to live on domestic trade. Export trade is, therefore, the life of the nation, and every thought and every energy is directed today in the interest of export.

Conditions in Switzerland

In Switzerland today there is only one machine-tool-building house of importance, and the same statement applies to Italy. Switzerland, however, is a larger user of machine tools of high grade. Here is a wonderful country, devoid as it is of coal and iron, yet enjoying almost unlimited water power; without a seaport, and yet manufacturing the highest grade of machinery of noted lines and exporting this machinery to all parts of the civilized world. For this work the highest grade of machine tools is demanded, and I know of no finer installation in all Europe of high-grade machine tools than can be found on the floors of the Brown, Boveri & Co. works in Baden.

Opportunities in Italy

Northern Italy promises in the next 10 years a greater industrial development relatively than any other part of Europe, and I know no part of the Old World so friendly to Americans as northern Italy.

At the time of my visit in April last I observed industrial plants in process of erection over a vast extent of territory on the south slope of the Alps. Italian and Swiss engineers have combined to make available a vast amount of electric power in the Alps for northern Italy.

Within the last two years and a half it is calculated that more than 50,000,000 lires ($10,000,000) worth of machine tools were imported for new Italian shops, and of this amount American manufacturers, it is estimated, secured about 60 per cent. My own view on the subject is that we should have secured 90 per cent. To be sure, many of the orders were for automobile factories, and much of this business has now resolved itself into a few large plants, but aside from the automobile business, the industrial development in northern Italy is exceptionally good and has been good during the present year. The Italians are enthusiastic about their country, declaring that it is a new country.

This territory should be studied by our manufacturer, and right here let me say that our great need is to export with our tools, *men*. Machine tools cannot be sold in Europe as at home. If the foreign trade is worth having, if our manufacturers believe that we should develop foreign connections, and be in position to avail of this foreign business, when to hold our organizations together, when affairs and conditions at home are below normal, then we must go at it intelligently and with fixed purpose. Men must be exported with our tools, and they must be men who will live abroad and become seasoned.

In France

American machine-tool business in France has of late been largely confined, it would seem, to the automobile builders, and yet there is an enormously rich section in central France where very few of our manufacturers are personally known and where very few go. I have referred in some of my special reports to finding certain American tools in interior French plants, which were not liked because they were not understood; on the other hand, I know of American machine tools which are regarded with special favor in certain shops.

That there is a vast market for machine tools abroad is apparent, not only from our own export figures, but from the export figures of other countries. The object of the Department of Commerce and Labor has been to assist our manufacturers in making known through the *Daily Consular and Trade Reports* the existence of possible markets, and the state of development in the trade in foreign countries. I think you will all appreciate that this requires close working agreements between our manufacturers and the department, and that exchange of ideas and mutual assistance which was suggested by the secretary in his address before the last national congress.

Machine Tool Builders Association

In Annual Convention Discuss Machine Tool Industry in Europe, Systems of Paying Employees and Commercial Side of European Trade

EDITORIAL CORRESPONDENCE

The Seventh Annual Convention of the National Machine Tool Builders' Association was held at the Hotel Imperial, New York City on Tuesday and Wednesday, October 20 and 21. President Eberhardt presided. In opening the convention, he referred briefly to the lessened business activity of the last few months due to the panic and politics, and laid stress upon the broad proposition that good years of prosperity must support the lean years of depression. A decided improvement has been felt throughout the trade, but the lessons of the panic and its attendant circumstances must not be forgotten. He suggested the establishing of two committees, the one to study foreign trade conditions, the other to study machine-shop accidents and means to prevent them. In speaking of the latter suggestion he mentioned a similar committee that was appointed by the American Foundrymen's Association at their last convention.

The treasurer's report showed a satisfactory condition of the finances of the association. Several interesting points were brought out in the secretary's report. During the past six months 20 apprenticeship diplomas have been issued, going to apprentices working in 11 different firms. At the last semi-annual convention a report was submitted on a uniform cost accounting, and a resolution suggested the installing of the system there outlined on the part of members of the association. Two circular letters were sent out by the secretary in order to determine to what extent this system had been installed. A brief tabulation of some of the more important items showed that five have the system in full operation, seven may modify their systems to meet the provisions of the report, two will put the system into operation when they are prepared to make changes in their present system, four will adopt the system with certain modifications, thirteen have at present no system but like the system as outlined, and twenty-four have fully established and organized systems of their own.

Two new members were admitted, The Powell Tool Company, of Worcester, Mass., and Charles G. Allen Company, of Barre, Mass.

Reports of the Standing Committees

Among the reports of the standing committees but one was given in detail, that of the Committee on Patent Arbitration. The report was presented by Mr. Shipley in the absence of the chairman Mr. Kearney. The tenor was distinctly against any attempt at patent arbitration among members of the association, as it was pointed out that the courts are the natural resort for such controversies. In the case of infringement an immediate injunction is often needed in order to protect the interests of the party whose patent is being infringed.

The address of the morning was given by Capt. G. L. Carden, of the United States Revenue Service. Captain Carden was detailed for duty as a special agent for the investigation of the European machine-tool trade possibilities under the direction of the Department of Commerce and Labor. His reports were made to the Bureau of Manufactures of the Department, and have been printed from time to time as part of the *Daily Consular Reports*.

His address consisted of a review of these reports, and a summing up of the condition of the machine-tool industry in Continental Europe. It was enthusiastically received by the convention, and is of such interest that we print it in another column, slightly condensed.

Mr. Doan presented a short paper commending the work of Captain Carden, pointing out its value to the industry, intimating that the work would cease unless action was taken to continue it, and urging such action by the association so that the proper officials at Washington would clearly understand the desires and needs of the industry. General discussion took place, but final action was deferred until a later session of the convention.

A vote of thanks was extended to Captain Carden and his superior, Mr. Carson, chief of the Bureau of Manufactures, and Secretary Straus, of the Department of Commerce and Labor, through whose courtesy the Captain's interesting address before the convention was made possible.

Wednesday Morning Meeting

At this meeting the firm of William E. Gang & Co., of Cincinnati, was admitted to membership.

A brief address was given by Mr. Corwine, assistant secretary of the National Council of Commerce. He reviewed briefly the organization of this council, which took place at Washington during last winter and was the outgrowth of a suggestion of Secretary Straus, of the Department of Commerce and Labor. He spoke of the growth of the membership of this council during the past few months, stated that the next meeting was to be held in December, at Washington, D. C., and expressed the hope that the convention would take action to have the association become a member of this council.

A paper was presented by Harrington Emerson, on "Different Plans of Paying Employees, with Advantages and Disadvantages of Each Plan to Employer and Employee." Mr. Emerson classified forms of paying wages under three heads: Time rewards irrespective of performance; performance rewards irrespective of time, and rewards for personality irrespective of time or performance.

Mr. Emerson's method is based on what he styles the "efficiency" principle. This takes into consideration three important questions, carefully separates them and studies each one without reference to the others. These three questions are: Current rate of wages, standard time for given work, individual efficiency. Many interesting records of experience were presented, showing a close agreement between predetermined standard time and the actual time taken by workmen to perform a given piece of work.

The discussion of this paper was general, turning to quite an extent upon how to predetermine standard times for various kinds of work. The difficulties of such a procedure were stated clearly, and it was pointed out that there is no such thing as a minimum time for doing any particular job. There is a constant tendency to reduce the time required for any particular operation, though at a decreasing rate as development continues.

Wednesday Afternoon Session

The address of the afternoon was given by J. W. Carrel, the AMERICAN MACHINIST's special correspondent. His address was based on the results of his trip through Europe during the past year; a trip that took him through fourteen different countries; his subject, "The Commercial Side of the Machine Tool Industry in Europe and a Review of European Conditions."

Mr. Carrel's address summarized the conditions prevailing in the European countries that he visited, outlined business conditions and commercial relations, and indicated points that should be emphasized by a firm that is developing a foreign machine-tool trade. In the past, the majority of machine tools entering Europe have been *bought*, not *sold*. Aggressive selling tactics, sending of full information and watchfulness as to quality of export product were insisted upon as essential in building up a trade in foreign markets.

Following this address the closing business of the convention was reached. A resolution was adopted expressing to Secretary Straus of the Department of Commerce and Labor, and John M. Carson, chief of the Bureau of Manufactures, the appreciation of the convention of the work that had been carried on by Captain Carden and asking that this work be continued, and that other European countries not already visited be investigated and reported upon in the same manner as has been followed heretofore. In this same connection it was voted to establish a permanent committee of twelve members, to be known as the Committee for the Promotion of Foreign Trade. This committee was instructed as one of its first duties to proceed to Washington and to urge upon the proper authorities the continuation of the foreign investigations in behalf of the machine-tool industry.

Uniform Cost Accounting

F. A. Geier, reporting for the committee on Uniform Cost Accounting, urged upon the members that greater attention should be paid to securing a clear understanding of just what production costs are, declaring that this understanding is necessary if competition is to be intelligent. He suggested that the various section committees take up the work among their own members. A resolution urged the adoption of the Miller and Franklin plan in its entirety, wherever possible; also taking action to provide a standard in the item of costs for the charging off of a percentage for capital invested for the yearly depreciation of tools, equipment, and for the depreciation of jigs, fixtures and patterns.

A report presented by C. Wood Walter suggested the desirability of revision of the constitution and by-laws in keeping with the widening scope of the association. This matter was left in the hands of the revision committee.

The election of officers resulted in the re-election of the entire official staff of the association. The selection of a convention city for the spring meeting developed a brisk contest, in which Milwaukee was finally selected over Rochester and Atlantic City.

This report should not close without reference to *Machinery's* annual outing, which occupied the entire day following the close of the convention and consisted of a sail from the foot of West Twenty-first street down the Hudson river, around Battery Park, up the East river under the great suspension and cantilever bridges to Point View island in Lond Island sound, where luncheon was served and gray heads became young again in an afternoon of sports.

Our contemporary is to be congratulated on its admirably conceived and executed entertainment which has become an event to which all in the machine-tool building industry look forward with anticipation.

Two Helps for the Tool Room

By Philip Bellows

The tool room of a modern machine shop often gives a true indication of the character and quality of the system of which it is a part. Often, by force of circumstances it is much more crowded for space in proportion than the rest of

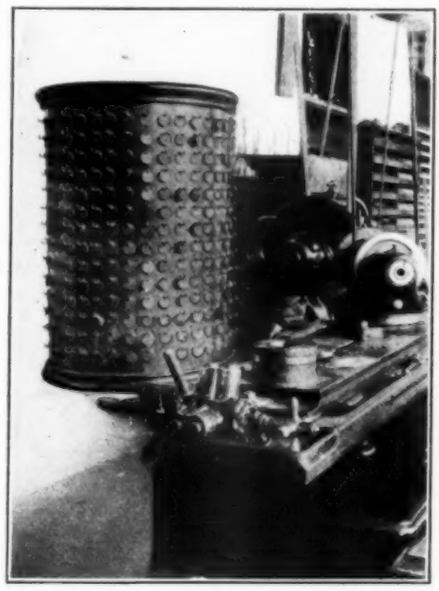


FIG. 1. A CHECK RACK FOR THE TOOL ROOM

the shop, and consequently the real character of the oversight which it receives can be gaged by its appearance to the eye of even a casual observer.

The ability to economize space to the best advantage in this department is often a valuable acquisition to the superintendent or tool-room foreman. Fig. 1 illustrates a case in point. Proper provision must be made for the systematic filing of the checks which each machinist is required to give for the tools he takes out. As is well brought out in the half-tone, all the available space on the walls is occupied by racks of twist drills, taps, reamers, and the like. It is true that the wall is bare above the 5-ft. level, and that there is plenty of room there for a rack. But a rack in that location would involve climbing two or three steps every time a check was used. Consequently, the piece of furniture here shown was devised to set in an unused corner of the grinding machine.

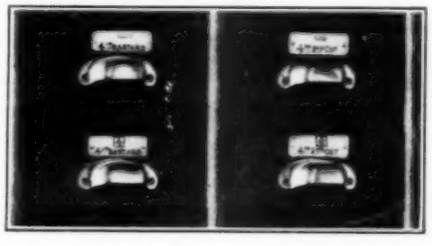


FIG. 2. PORTION OF FILE RACK

The shop in which this was seen is one which prides itself on certain elaborations which some superintendents and foremen would consider unnecessary. While by no means costly, this device could be installed at even less expense. A pattern-maker could build the drum from double thicknesses of spruce with the grain crossed, nailed together and sawed to a correct circle in the band saw. The body could be made of soft-wood strips, 1½ inches wide by ¾ inch thick, with the edges square but not necessarily as carefully jointed as in the case here shown. After the latter are nailed in place, a coarse set plane passed once or twice over the joints would give the body sufficient symmetry; then a jacket of brown packing paper tightly glued, or pasted to the drum, would complete a body good enough for the majority of cases. With a coat of varnish or paint and a suitable outfit of hooks, the rack would be ready for business with the exception of the pivot on which it would turn. The latter might consist of a piece of ½- or ¾-inch galvanized pipe and a hardwood washer 4 inches in diameter and ½ inch thick with a hole in the middle to slip over the pipe. There is no reason why this idea should not be carried farther and used for snap gages, dies, and indeed any tool that can be hung on a small hook. Such a rack has one great advantage besides that of economy of space; it is much easier to keep clean than a pigeon-hole rack, which can hide grit and dust to the detriment of its contents.

File Drawers

Fig. 2 illustrates a device to economize time. Somebody once got into the tool room, so to speak, of one of Uncle Sam's battleships; what he brought back is shown as one of the best things he saw there; a system for the storage of files so that each size, shape and cut can be located with a minimum of delay. One remembers with a feeling of impatience the delays incurred in some old-fashioned "store room" (they are not all done away with yet) as the man who waited on you took down a pile of cardboard boxes, one after the other, and carefully examined the label on the end to see if the contents corresponded with what you had asked for.

The few drawers of Fig. 2 are about one-fifteenth of the set from which they are taken, but they will serve to show the idea. Here again it is not necessary to have brass slips. What will serve the purpose just as well is a blueprint that can be cut up and pasted on the drawers or pigeon holes.

I think one improvement might be made in arranging the drawers. Would it not be easier to locate a file if it was grouped according to its shape, and not according to the length?

Practical Letters From Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

Fixture for Forming Leather Boots for Flexible Couplings on Automobiles

All flexible couplings, such as universal joints, etc., on automobiles, are usually covered to keep out dust. Leather is usually used for this purpose and it fills the need completely. To be of the best design and properly do their work these leather boots should be formed to fit the flanges of the joint and clamped in place.

The fixture shown herewith is for forming these boots. This one in particular was made for a boot covering a universal joint, but its construction may be varied to suit any sort of a flexible coupling. The fixture consists principally of a form *A*, and a clamp *B*, as shown herewith. The form *A* is a hollow cast-iron shell, turned on the outside to suit the required shape of the boot. It should be sawed at *J* into halves and the part sawed out replaced with a liner.

The clamp *B* consists of halves jointed together at *C* by the hinge-pin *D*, and drawn and clamped together by the eye bolts *E*. The handles *F* are screwed in at *G*. The halves of the clamp *B* should be bolted together and turned inside to suit the outside of the form *A*, its inside diameters being twice the thickness of the leather larger than the corresponding outside diameters of the form *A*.

The plain leather boot is sewed, as shown at *H*. It is then soaked in water for a short time until it becomes soft and

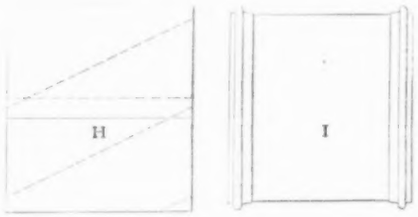


FIG. 2. THE BOOT FINISHED AND UNFINISHED

pliable and then stretched over the form *A*. The form with the boot stretched over it is placed in the clamp *B* and the nuts on the eye bolts are turned down tight. The leather should be left in the form and clamp until it is nearly dry. It may then be removed and it will remain in the desired shape, as shown at *I*.

To remove the form from inside the boot the liners at *J* are knocked out and then the halves of the form are easily removed. It is best to have a number of the fixtures made so that it is not necessary to wait while the drying is taking place. This fixture has proven itself a complete success.

Washington, D. C. R. B. LOVEJOY.

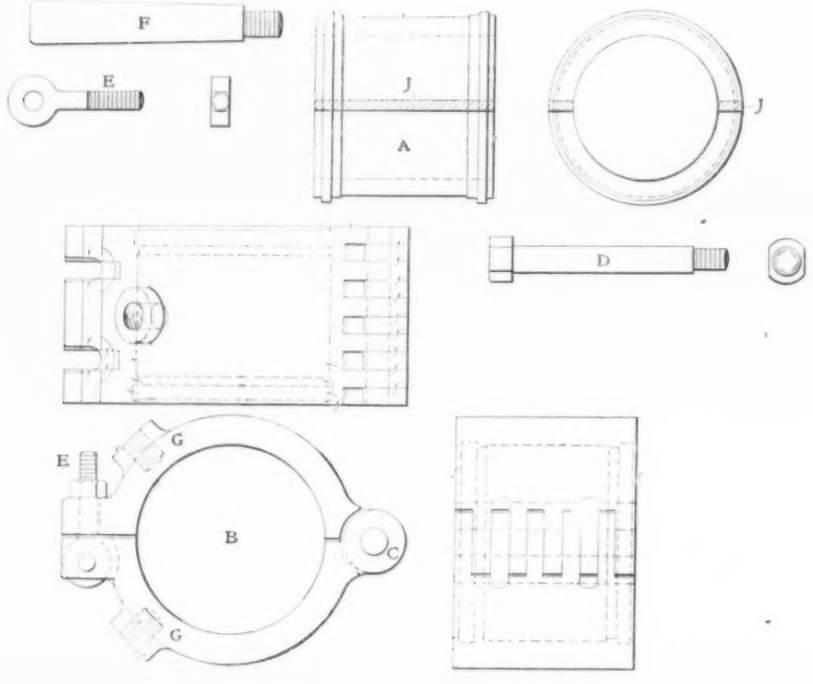
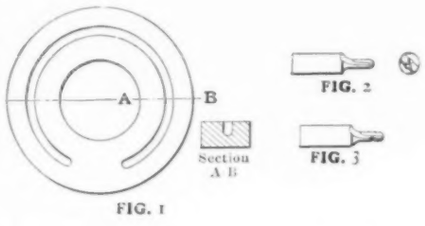


FIG. 1. FORM AND CLAMP FOR LEATHER BOOT

Building Machines on the Crate Base—Milling Small Grooves

The small shop usually makes up for its lack of facilities, or its other handicaps by increased ingenuity. In a recent case where a number of heavy machines were to be built and the crane and hoist facilities were a minus quantity, the difficulty was overcome by first building the base or cradle of the shipping crate; this was mounted on blocking and the machines erected directly thereon. After



THE WORK AND THE TOOL

completing the crating it was a simple matter to put rollers under and knock out the blocking. This was only a small item, but the time saved all went on the credit side of the account.

Another little thing, but one which resulted in doubling the output of the machines, came under my observation some time ago. The groove, shown in Fig. 1, was to be cut in the face of a bronze ring. As this groove did not extend completely around the ring, but through an arc of about 320 degrees, being ⅛ inch wide and 0.2 inch deep, bottom semi-circular, milling was necessary. A drilled hole was the starting point and the cotter drill, shown in Fig. 2 was used. Various combinations of speed and feed were tried, but it was finally decided that two cuts were necessary on the job. Even at this, the cutter breakages were numerous, as the metal was of a very tough composition. Finally, someone suggested the grinding of two nicks in the cutters, as shown in Fig. 3, for breaking up the chip. Since then the full depth of cut is taken at once, same speed and feed as before, and the expense of cutter maintenance is much less.

Philadelphia, Penn. C. W. PITMAN.

Some Old Machine Tools Still in Commission

Fig. 1 shows two automatic gear-cutting machines designed and built in the Bement shop in Philadelphia in 1857. These machines are still turning out good work and are likely to do so for some time to come. On looking at the solid design one can scarcely believe that these tools were built 51 years ago.

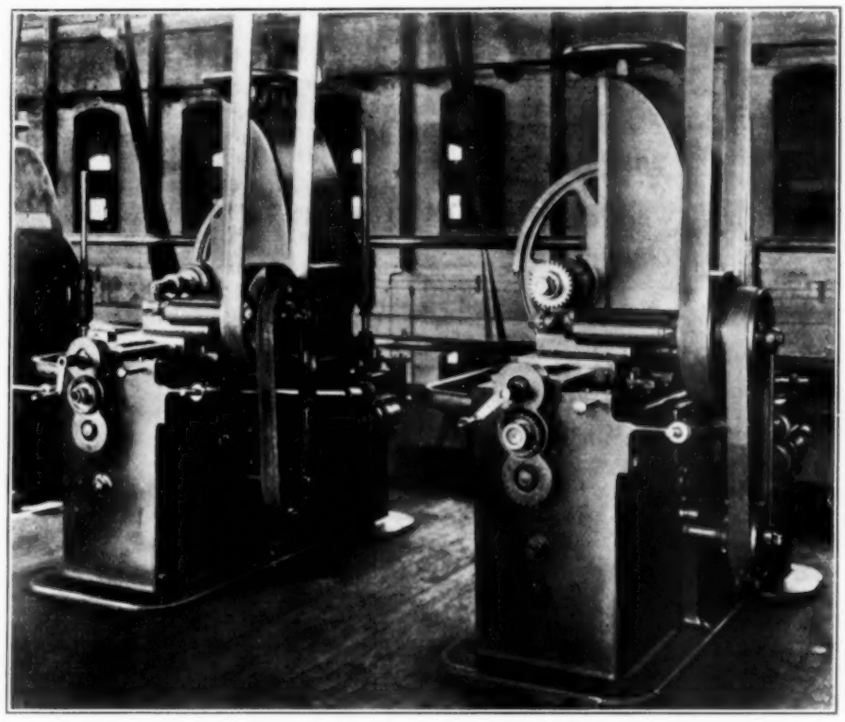


FIG. 1. AUTOMATIC GEAR CUTTERS 51 YEARS OLD

Fig. 2 shows a cottering machine with single head designed by the same firm in 1858. This machine is automatic and has a capacity for cutting slots 1¾ inches wide, 9 inches deep, and 36 inches long.

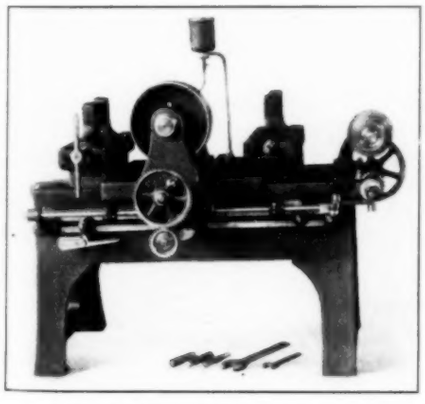


FIG. 2. SINGLE-SPINDLE COTTERING MACHINE

Fig. 3 shows practically the same machine, but with two heads, which allows for cutting two keyways at the same time, or for cutting a slot entirely through the shaft. When cutting through slots the two heads are set so that they feed toward each other. When the ends of the drills are very close to each other at the center of the shaft, one head automatically throws out, while the other one continues its operation until the central portion of metal is cut entirely out. When the one head is removing the central portion of metal, the other head is automatically pushed ahead of the one removing metal so that the tools cannot possibly come together. The machine is provided with centers as shown so that a shaft if not too long, can be held at the ends. If at times there is long shafting to be cottered it can be held in two vises, or one center and one vise. Below the bed of machine is shown a flat table, which is sometimes found useful for cutting slots in irregular work.

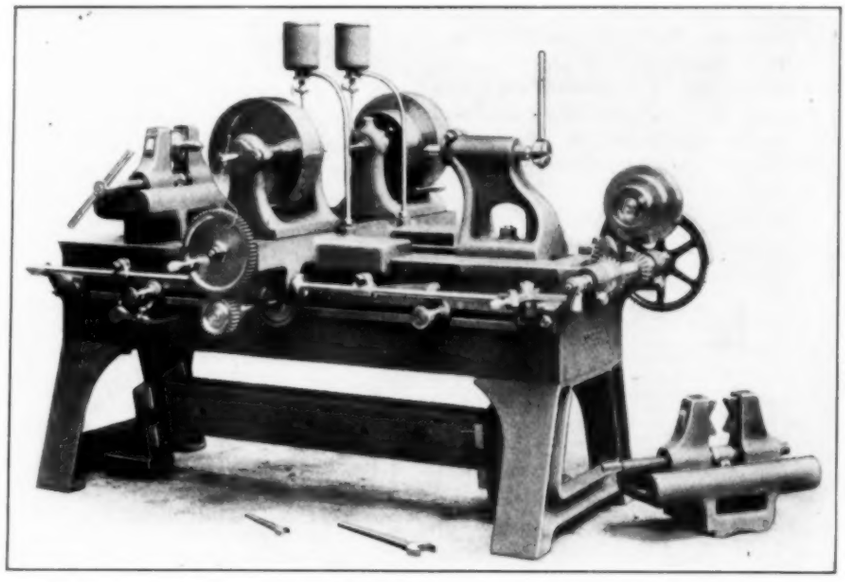


FIG. 3. DOUBLE-SPINDLE COTTERING MACHINE

New York. W. J. H.

Cutting a 20-inch Gear on a 10-inch Dividing Head

We had a gear 20⅛ inches diameter, 2½ inches face, with 99 teeth to cut, and nothing but the regular B. & S. dividing head to use for spacing it while being cut in the milling machine.

An arbor was made fitting the spindle of the universal head. The gear was mounted on the arbor in the head. An angle plate was fastened to the table of the milling machine. To this angle plate the universal head was fastened, the axis of the spindle being vertical and the gear to be cut, on top. The gear was then cut by using the vertical feed.

Quebec, Canada. H. R. YOUNG.

Method of Making Name Plates

Once in a while we want a name plate, or an index plate, for a special machine and we do not feel that we can afford to have a milled pattern made, because there is no certainty of its being used but once. To get around this difficulty I have had patterns made in this way: I got a friend who runs a rubber-stamp business to set up what I wanted in type. Then he flooded it with something that they use to fill in the spaces, but filled it up fuller than for a rubber stamp, in fact just as full as he could and not run over the letters anywhere. An electrotype from this when fitted with a lead backing, made just the thing for a pattern at only 20 per cent. of that of the regular pattern and greater saving in time.

Springfield, Mass. ENTROPY.

Duplex Slotting Attachment for Fire Hose Couplings

Attachments and fixtures are seldom designed for the slotter now, as the milling machine, with its formed cutters, etc., has robbed the slotter of much of its work. There are cases where the slotter can still hold its own with the miller. A typical example is the fire-hose coupling shown at Fig. 1. This is of the old-fashioned screw coupling type turned all over except the part marked *A*. The inside bottom end is threaded 6 threads per inch.

Anyone who has tried milling the part *A* will admit that a good finish cannot be obtained. Having large quantities to make we designed the slotting attachment here shown, which we fitted to a 6-inch slotter in our shops. With this attachment a boy can easily slot 12 couplings per hour, and make a really first-class job of them, as the sharp-pointed cutting tool leaves a very fine finish. The couplings are screwed onto a mandrel, *K*, as shown in Fig. 3, which is secured in the center of the circular table *L*, the turned face *B* of the coupling locking onto *K* by a tap with a rawhide mallet on the short arms *C*. *D* is a planed casting which fits on the slotter ram *I*, as shown, and is secured by the four set screws *G* which screw into nuts in the T-slots for the tool holders. *E* are two slides which fit on *D*, with two T-slots in each for carrying the tool holders. These two slides, or tool boxes, are adjustable by the two screws *F*, which are dropped into slots in *D*, as shown, and held in position by the two solid collars on each. They operate independently, through two nuts, cast solid on the inside at the back of *E*. *H* are two round tool bars, which fit in a shallow V planed in the center of *E*, shown at *J*, on the top, in Fig. 3.

It will thus be seen that both the tool bars operate at the same time, therefore, only half the distance travel is required which would be necessary with a single tool. Referring to Fig. 2, which is a plan of the hose coupling, the surface traveled over when slotting is indicated by the two arrows. The two cutting tools both commence to operate at the point marked *M*, close up to the shoulder of the two spigots *C*. The circular motion of the table is then thrown in, and the table travels until the point *N* reaches the tool, when the machine is stopped and the couplings are completed, although the table has traveled little more than a third of a revolution.

London, England. HYDRANT.

Boring Mill Work on a Radial Drill

A drop forging company ordered a drop press which was not unlike other drop presses except that they wanted a plate about 15 inches diameter and 4 inches thick set in the top of the die bed.

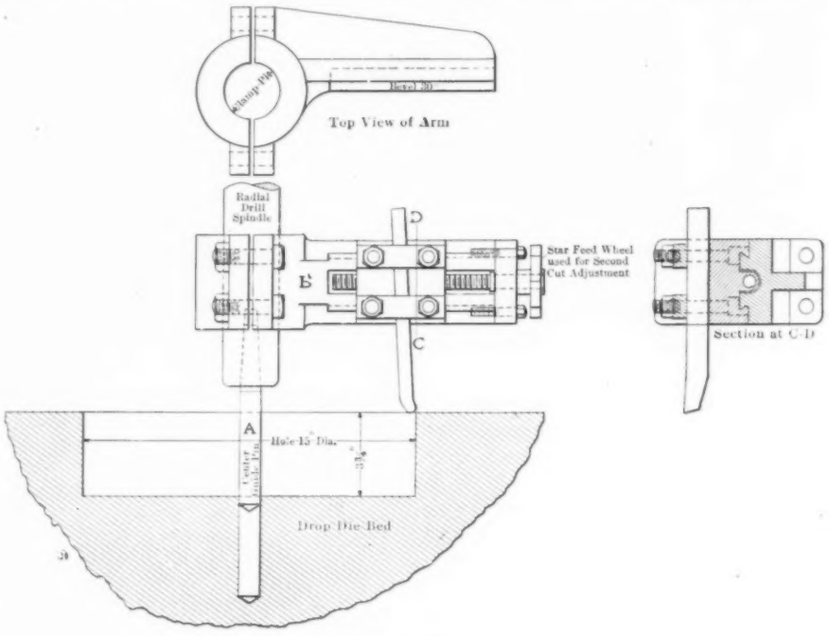
We had no boring mill so the foreman decided that the radial drill would be the handiest to do the job.

The hole being cored out, he found the center at the bottom, and run a 1-inch drill down about 4½ inches to guide the center pin *A* which was about 5 inches long.

He then had a pattern made of the arm and cap *B* which is shown in the accompanying cut, and had them bored a clamping fit and bolted them to the drill-press spindle.

Then putting a tool, similar to that shown in cut, in the tool holder and adjusting it by the star feed at the end of arm, he soon had the hole bored out to the right diameter.

When he came to facing off the bottom of the hole, he took an end mill about 1½ inches in diameter and run it down the



THE RIG USED ON THE RADIAL DRILL

right depth on one side of the hole, and then by feeding it back and forth across the hole it was not long before he had that part of the job, which was the most difficult, done.

B. H. W. SCHULTHEISS.

New Haven, Conn.

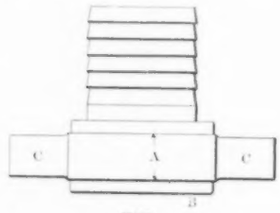


FIG. 1

FIG. 2

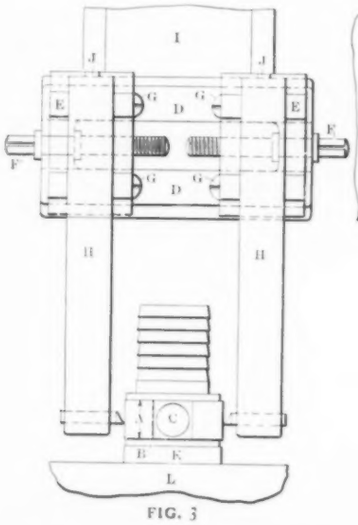


FIG. 3

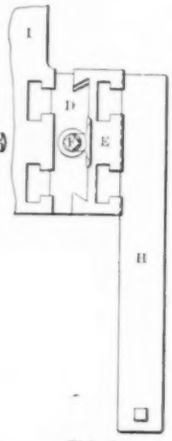


FIG. 4

THE WORK AND THE DUPLEX SLOTTING ATTACHMENT

Another mechanical device that will assist the automobile in relegating the horse to the rear is reported to have been introduced in the German army. The device is what might be called a steel horse, saddled up, and connected with electric current. The steed is mounted, current turned on, and by novel contrivances the arrangement is made to go through the exact motions of a real horse in action. The rider is enabled to slacken and increase the speed by screw adjustment, and the exerciser can be rigged up to accommodate any weight.

Discussion of the Previous Question

Letters from Our Readers Showing How Many Men of Many Minds Look upon Various Subjects Opened up in Previous Numbers

WE PAY FOR THESE ALSO

The Suggestion System

I have been much interested in your editorial on page 392, "The Other Side of the Suggestion Box." That many such installations have failed totally and that others have been great disappointments to their advocates is undoubtedly true, but in every case "there is a reason," and it is surprising how many of these reasons are the same, viz, a misconception of the function of the system and consequently its improper application and method of operation.

In the first place it must be remembered that the suggestion system is only one of a number of so-called "industrial betterment" features, all of which go together in the reorganization of a plant in changing the management from "one-man control" to more democratic methods. These methods were developed in Germany some 25 years ago. Some of our progressive manufacturers who were then beginning to make frequent trips abroad for the purpose of investigating foreign methods were not slow in taking cognizance of them nor in recognizing the economic principles underlying them and after studying them carefully adopted them in their entirety in their shops in this country. The success attendant upon the operation of these installations developed a horde of imitators who, without investigation or thorough understanding of the functions of the separate features which were parts of them, adopted such of the latter as they took a fancy to, and instituted homemade applications as best they could. These are the suggestion system and other systems of similar purport which you refer to as having so signally failed.

The suggestion system *per se* is all right in theory and in practice, when properly operated, is an unqualified success as a developer of business and a money maker. Like any other system, however, when improperly installed and operated, it cannot help but be a failure.

An Example

Some time ago, when called upon to resuscitate a manufacturing concern which had failed, I reorganized the shop on modern lines and installed as part of the new organization the suggestion system. It was not many months before the business was on a paying basis. When I turned it back to the owners I told them that they would have to keep the organization as it was then constituted, if they wanted it to continue to progress. The old manager, however, told me plainly that he knew nothing about management along the lines I had introduced. He said he looked upon me as a business doctor called in to see a very sick patient. He said he considered the suggestion system and other similar features as excellent tonics which had served their purpose in reviving the business, but now that it was on its feet it would have to stand and go alone. I told him that the whole business had been modernized to meet present conditions and that if he attempted to alter the methods then in vogue it would be extremely hazardous.

He was of the "one-man control" school, however, a regular slave driver, and it did not take long before old methods began to replace the new. By the time the financial panic came it had again so run down that it went completely to pieces. He came to me again for assistance, but I told him the patient was a corpse this time and that I could not galvanize it back to life.

In another plant the manager, when I told him what I proposed to do, said that he had already tried the suggestion system and it had failed. I got him to tell me about his experience with it. He was also a manager of the old-school type and nothing happened about the place if he could help it, without its being brought to his attention. His installation of the suggestion system consisted in placing a box at the entrance of the place with a notice on it to the effect that suggestions dropped into it would be paid for if accepted.

He said that everybody in the place seemed at first to feel that it was incumbent upon him to put in at least one suggestion a month, or else he, the manager, would think that he, the employee, was not interested in the welfare of the business. The suggestions were, however, so irrelevant to what he felt he needed that he never paid for any, and after a few months they stopped, and he took the box out. There was no system about this at all, and yet the manager apparently thought it was so perfect that it ought to work automatically.

How can a man expect an imperfect device to work at all satisfactorily, especially if he leaves it alone, without either assigning someone to make it work, or paying any attention to it himself?

A Failure Not a Suggestion Failure

I have an instance in mind of a similar character where even an everyday commodity would not work. The president of a very large manufacturing concern said to me some time ago: "I recently put up a new building at my works and knowing that only high-grade mechanics would be employed there I had a lavatory built in it so that the men could wash up before going home. I was, however, very much disappointed to find that the men did not use the wash basins at all. I am through with all refinements in shop organization from now on."

"Well," I said, "I am surprised to hear what you say, for similar arrangements I put into some of your other buildings seem to be appreciated and are generally used. What do you suppose was the matter?"

"I haven't the slightest idea," he answered slowly, as if it was just dawning upon him that there might be something the matter with the installation instead of with the men. "I wish you would take a look at the layout and report to me what you think of the situation."

So I took an early opportunity to visit the place and this is what I found: A splendid brick building 340 feet long by 60 feet wide, three stories high, the second story 22 feet high and the third story 18 feet high, well lighted and heated. Machine tools were in long rows on each floor extending the full length of the building. At the entrance at one end were two double rows of wash sinks, 20 in all, supplied with cold water. No soap, no towels, no lockers! No hooks on walls to hang up coats, nothing but sinks and cold water! Building designed to accommodate 200 men and 20 sinks!

Each workman provided himself with a tool chest for his small tools, and this he kept adjacent to the machine he was operating. Now what would a man in an average location, say half-way down the shop on the first floor, have to do to avail himself of these washing facilities on going home at noon or night? Let us see.

First, he would open his tool chest and take out his soap and towel, then he would take off his overalls and put them in the box and lock the latter for safety. Then he would walk 170 feet to the wash room and wait for a vacancy. When his turn came he would wash up as best he could with cold water, holding his towel between his knees or over his shoulder. When finished he would walk back to his box 170 feet, take out his coat and hat and put in his soap and towel and walk to the door 170 feet. This entailed a walk of 510 feet and a lot of inconvenience.

He would go through this performance only once, and would wash his hands in machine oil at his place and wipe them on waste, place his overalls in his box, put on his coat and hat and walk 170 feet to the door and go home and wash there with hot water. This would entail a walk of 170 feet instead of 510 feet, a saving of 340 feet for the average man, and twice as far for the man at the end of the shop, and all kinds of distance and down and up and down stairs again besides for the men on the second and third floors. The man at the far end of the shop on the top floor would have had to walk just one-fourth of a mile, including the two trips down stairs and one trip up. When I reported my findings to the president he made a remark which was more forceful than polite, and said, "d.....d if he wouldn't do the same thing himself if he was in their place."

So you can see that innovations in shops of other than suggestion systems can fail if they are not put in right, and the reason of their failure remains a mystery, if there is not someone, who has an interest in making them work, to take the trouble to investigate and apply the remedy.

There is no trouble about making the suggestion system work when it has proper environment, but there is much more to it than a suggestion box, and it will require someone to give it just as much attention as is given to any other institution in the shop, and if it does not work right or stops working it will be because the man in charge is negligent or does not understand its method of operation.

The old school manager installs the suggestion system with the principle in mind which he always has applied to his organization, viz, to get out of it as much as he can and give as little as possible in return. He has probably learned after long schooling that he cannot get something for absolutely nothing, so having heard of the suggestion system he resolves to try to use it, to induce his people to give up ideas and he can be depended upon to foozle things later about adopting them and paying for what he has to. No wonder such systems fail.

Fair Treatment Must be Given

The new school manager has been taught that human nature is the same the world over and that if he wants fair treatment from others he has got to give it himself. So he organizes his shop on a democratic basis giving his employees something to say in the nature of suggestions and lets them pass upon them through committees in a recommendatory way. There is a spirit of "get together" in this method of management and if anything goes awry it is at once adjusted. The suggestion system *as a part of such a system* cannot fail to work.

And not only does it bring in direct returns in the nature of improvements of all kinds about the shop but it indirectly benefits the business by developing the powers of observation and ability of expression of the employees. It also arouses their ambition to advance by improving their capabilities. It excites their interest in the company's affairs when they see that they are taking an active part in promoting its welfare and are getting benefited by it

The employer by being brought into closer touch with the needs of his employees more clearly recognizes that they are subservient to his direction for a large proportion of their waking hours, and realizes his obligations as a man to them as fellow human beings, as a fellow townsman to the community where his factory is located and to his country as a citizen that these people should be benefited rather than impaired not only physically but mentally and morally by employment in his service.

Such an employer is not a slave driver but an enlightened coöperator in advancing the interests of the business and of his individual employees, and the latter in turn give the best service to the company. So harmonious become the relations between employer and employed that so-called "labor troubles" are eliminated altogether, and a united organization builds up normally and healthfully from within.

Germany understands these principles and has so encouraged their adoption that her industrial supremacy is now threatening that of England and the United States as a foregone result.

New York City. H. F. J. Porter.

[An outline of Mr. Porters' successful suggestion system was presented by him in a paper to the American Foundrymen's Association. From that paper we abstract the following paragraphs.—Ed.]

We must organize the shop forces on a democratic system of government very similar to that which exists in our States or at the National Capital.

"According to this plan there is first formed a lower house, or works committee composed of representatives elected one from each department of the shop and office. Lots are drawn so that the terms of service of the members cease in rotation one dropping out each month and a new member being elected in his place. This arrangement brings about a gradual but complete change in the personnel of the committee in the course of a year or so, and gives many men in the shops a chance to serve. The chairman is elected by the committee from its members. The upper house or advisory board is composed of the shop foremen and the heads of the other departments. These remain permanently in office and are presided over by the general manager. To provide subjects for these two bodies to consider a "suggestion system" is established. This consists of locked boxes distributed throughout the departments. Through a slot in each can be dropped signed suggestions on proper blanks prepared for the purpose. No anonymous communications are recognized. These suggestions may be on improvements (a) in design, (b) in workmanship or (c) material entering into the product, (d) in processes of manufacture, (e) in methods of business, and (f) in conditions about the shops.

"These suggestions are periodically collected by someone selected by the works committee as secretary, who copies them with the name of the author removed, submits them to the works committee for consideration, and keeps a careful record of the recommendations for adoption or rejection of each.

"The minutes of the committee, consisting of these recommendations, are posted on bulletin boards in the shops and the following week they come before the advisory board for consideration. The chairman of the works committee is admitted to the meetings of this board by courtesy, but without power to vote. These minutes, consisting of the indorsement or rejection of the recommendation of the works committee are in turn posted on the bulletin boards in the shops and finally brought to the president by the general manager for final disposal. An estimate of the cost of installing each is made as well as an estimate of the value to accrue from it, and a balance is struck. All those which are accepted by him are paid for.

"It is also found advantageous in some cases to pay quarterly a bonus to the employee making the best or greatest number of suggestions, and to the foreman from whose department the greatest number emanate. The object in posting the minutes of the meeting in the shops is to insure publicity of the actions on all suggestions submitted. Right here is where public opinion is created and herein lies the success of the system. This publicity tends to restrain the rank and file from making foolish suggestions and prevents the two committees from acting otherwise than fairly on what comes before them. Once a month there is held a joint meeting of the works committee and the advisory board, in the evening, all having supper together and continuing in session until all matters at issue are thoroughly discussed and settled. These meetings offer a safety valve in which to vent the feelings of all hands on matters of dissatisfaction and here many a 'labor trouble' is met at its inception and adjusted."

A Device for Turning Crank Pins

The sketch of the device for turning crank pins, by W. Gibson, on page 207, recalls the fact that a certain south side Chicago shop, which made almost the same size crank shafts as those described, after trying various schemes, finally resorted to the drill press.

A fixture was made to clamp on the bed

plate of the drill press, that would hold the crank shaft upright. A hardened and ground, split taper bushing, similar to the one shown by Mr. Gibson, was used to hold the shaft firmly in place, the crank resting between adjustable stops.

A box tool of the usual double-wing type, with hardened bushing, adjustable tool slide, and Morse taper shank, was used in the spindle to do the cutting.

By using the double-wing box tool and the removable taper bushing the crank shaft could be put in or taken out of the jig with a good two inches to spare between it and the side of the box tool, without having to run the drill press spindle above the stroke given by the hand lever. This leaves ample room for the operator to avoid skinning his knuckles.

While the casting for the jig was in all probability no heavier than Mr. Gibson's, it cost less to machine and the average time for the two operations, of roughing and finishing, and consequently two handlings, was five minutes, or three minutes for the roughing cut and two minutes for the finishing. No soap water, or other cooling compound, was used, except a little lard oil that was squirted on the pin, before the box tool was brought down.

Two different box tools were of course used, but all the work was done in the same drill press. One lot of the crank pins was roughed off, then the box tool was changed and the pins finished to size.

Decatur, Ill. ETHAN VIALL.

Boring and Turning

On page 247 there appears an article under the above heading in which the following statement appears: "There were no spare holes in the turret."

Some time ago I came across this same trouble in a job I had in hand which demanded seven or eight tools, I forget which. The only way out of the difficulty seemed to be either a second operation on another lathe, or one of those objectionable combination tools which waste more time in use and cost more to construct than the job is worth. I often find, when a problem of this sort comes up, there are two good things to do. One is, to look through the indexes of the AMERICAN MACHINIST; the other, to "nose 'round" in the tool room, or its equivalent, if you haven't one. That time the latter was handiest, and I found a tool for which I have had considerable use from time to time. In this case its application robbed me of one hole in my turret, but added six more holes to my turret equipment, so I was satisfied.

In one of the turret holes I mounted an Almond turret which had been bought for use on the speed lathe, and with it the job was done satisfactorily with only the added cost of making a new shank to fit the turret hole.

New York. E. A. DIXIE.

Water Nozzles on Grinding Machines

I have read with interest the account of Mr. Bath's water nozzle for grinding machines. An advertisement also, in the same issue pictures a burning match near the water and wheel, and calls the nozzle "the wizard."

The publication of this matter at this time is very interesting as illustrating the fact that the larger part of the details that make up a design, invention, or improvement in machine tools are rarely ever seen or understood by the mechanical world even though they be in use for years, and under the eye of all. The nozzle shown and described has been in use on the best known and most used grinding machines for twenty years.

It was some time in 1887 or early in 1888 that I had the following experience: In arranging for a very small stream of water on grinding machines a small funnel was made as shown in Fig. 1. The water was dripped into the funnel from a pipe above, but water would many times be blown away from the wheel and work as shown. I then noticed that workmen put a wire in the funnel as shown in Fig. 2, to guide the water on to the wheel and work. At that time no one expected to use more than a very small amount of water and the need of more water later, proved the wire scheme inadequate. Noting the action of the water on the wire, I conceived the idea of making the nozzle itself a hollow wire, as it were, and cut the funnel nozzle away on one side as in Fig. 3, with the desired result, as either a very small stream or a pipe full would flow toward the wheel.

We then fitted all Brown & Sharpe grinding machines with this form of nozzle, although the funnel was discarded and a pipe substituted as in Fig. 4, which is like the one shown by Mr. Bath, so far as the essential features are concerned.

Norton grinding machines have been supplied with this form of nozzle since their first appearance and this form would be ideal for small streams of water if it were not for the fact that users cannot, or will not understand that when they press the nozzle against the wheel it will be ground by the wheel like any other piece of metal, and that when the original shape of the nozzle is ground away the water will no longer flow toward the wheel but will be blown about and on the operator.

To overcome this trouble, to secure good results in spite of carelessness, or of accidents and to enable the operator to deliver the water in such quantity, such form, and at such an angle as may best serve his purpose with the great variety of conditions imposed by the various diameters and shapes of work, as well as depth of cut, width and grade of wheel, the deflector was designed and added to the original nozzle.

WHY NOZZLES DO NOT SPLASH

It is asked what causes the water to flow toward the revolving wheel through the air currents that are moving from the wheel.

I have always believed that capillary attraction was the cause. It seems evident that if one side of the pipe be cut away on an angle that the water must follow the other side to, and off the point, and if the point be smooth and curved a little toward the wheel, that the water must continue to flow toward the wheel. When we consider that there is really very little force to the air currents from the face of the wheel, it is easy to understand that the water being heavier than air, when once started toward the wheel will penetrate the air currents.

The success, however, of this form of nozzle depends upon the mouth being so shaped as to deliver a smooth stream, as any stray drops will be caught by the air currents from the sides of the wheel and scattered, for the air currents from the sides of the wheel are quite strong.

A wide, thin stream will be caught by the side currents and scattered. That part of the stream, however, that covers the face of the wheel only, will flow onto the wheel if delivered from a pipe cut at an angle or from a trough as Fig. 5, if the stream is not too thin or too light. In the latter case the water will be scattered by the air from the face of the wheel also. Now by using a pipe cut away on an angle and flattened like Fig. 6, we can deliver a thin stream and still prevent its being scattered as it is delivered edgeways to the air currents.

We can also deliver a large stream without its sides coming within the path of the side currents. The water nozzles for Norton machines were first made as in Fig. 6. It was discovered, however, that when large amounts of water were required, a wide stream as well as a narrow one was sometimes necessary and that different conditions required that the water be delivered at different angles as well as different shapes of the stream. The deflector shown in Figs. 9, 11, 12, 15, 16, 17 and 18 was designed to meet the requirements and added to the nozzle shown in Figs. 10, 12 and 13.

Many operators will, if possible, turn the nozzle as in Fig. 7, in spite of the fact that water will then be blown directly on them. The one shown by Mr. Bath has the merit of being "fool proof" in this respect.

OTHER POINTS TO CONSIDER

There are other points than the shape of the nozzle that must be considered. One important point is that the wheel guard should be made to just touch the wheel face at *A*, Fig. 8, as then there will be less air currents at the nozzle.

Many operators allow the guard to stand away from the wheel face and then get wet or wear rubber suits to keep dry. An operator who has not learned this sim-

ple fact about the water cannot lay claim to being a good grinder.

The water nozzle, as first made for Norton machines in 1900, is shown by Figs. 13 and 14. It will be seen by a glance at Fig. 13 that a very small stream will flow directly toward the revolving wheel. So also will the larger streams in Fig. 14 flow smoothly when the wheel is revolving at full speed, but while a burning match is seen near the water in the photos it proves nothing because the wheel was not running when the match was burning, and no match will burn near a two-inch face wheel that is running 6000 feet per minute, whether there be water there or not, for while the air currents from the wheel face are not sufficient to disturb the flow of water they will instantly extinguish a burning match. Thus the picture of a burning match in front of a grinding wheel and its water supply does not prove anything in this case.*

Experience has shown that although a stream like Fig. 14 can be run smoothly from such a form of nozzle and against the face of a rapidly revolving wheel, yet when work is in position the water will be blown toward the operator as shown by Fig. 10, if enough water is used to meet modern demands for production and a wide range of work.

*This must not be charged against Mr. Bath, as it was the artist's way of showing that the water did not splash.

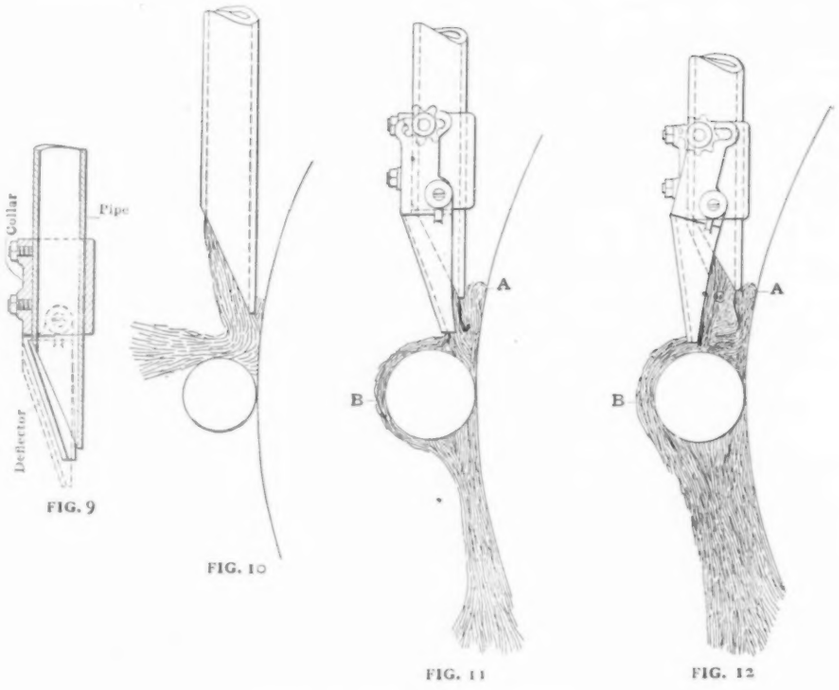


FIG. 9 FIG. 10 FIG. 11 FIG. 12

ACTION OF WATER FROM NOZZLES

Deflecting Nozzle

It was to provide for the large range of work and the ever varying conditions affecting the water that the deflecting, adjustable nozzle was designed. Almost every different piece of work necessitates a different application of the water, if cleanliness and rapid production are secured. The direction of the air currents is effected by the diameter and form of the work, as well as the width of the wheel; while the intensity of the air currents is

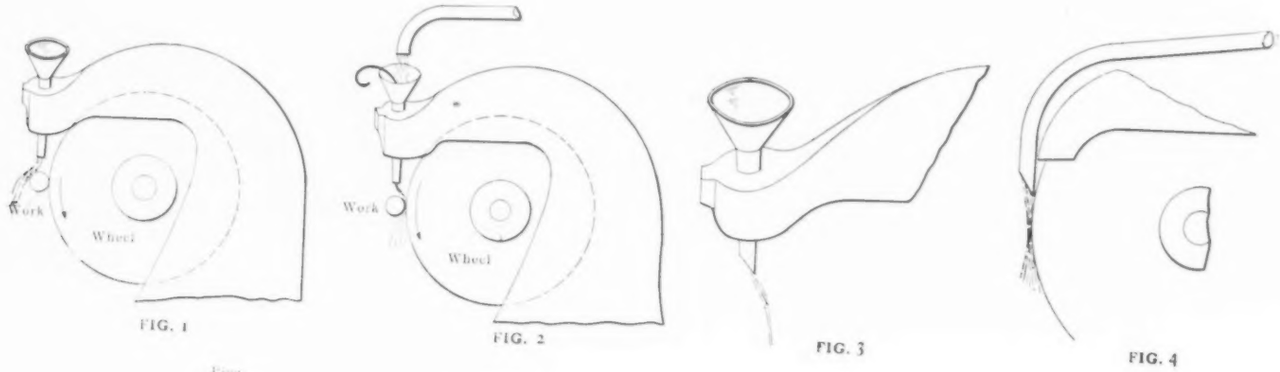


FIG. 1 FIG. 2 FIG. 3 FIG. 4

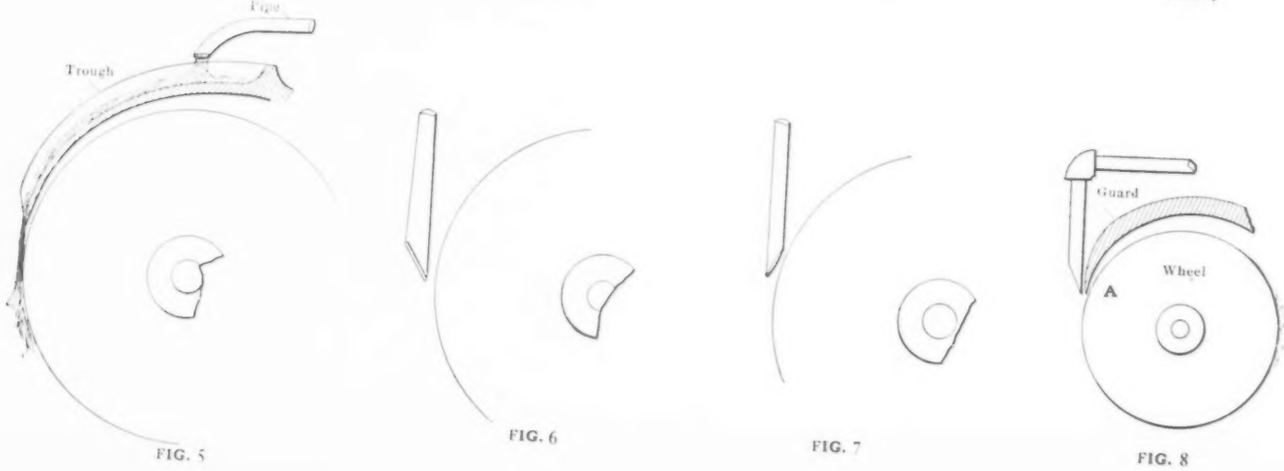
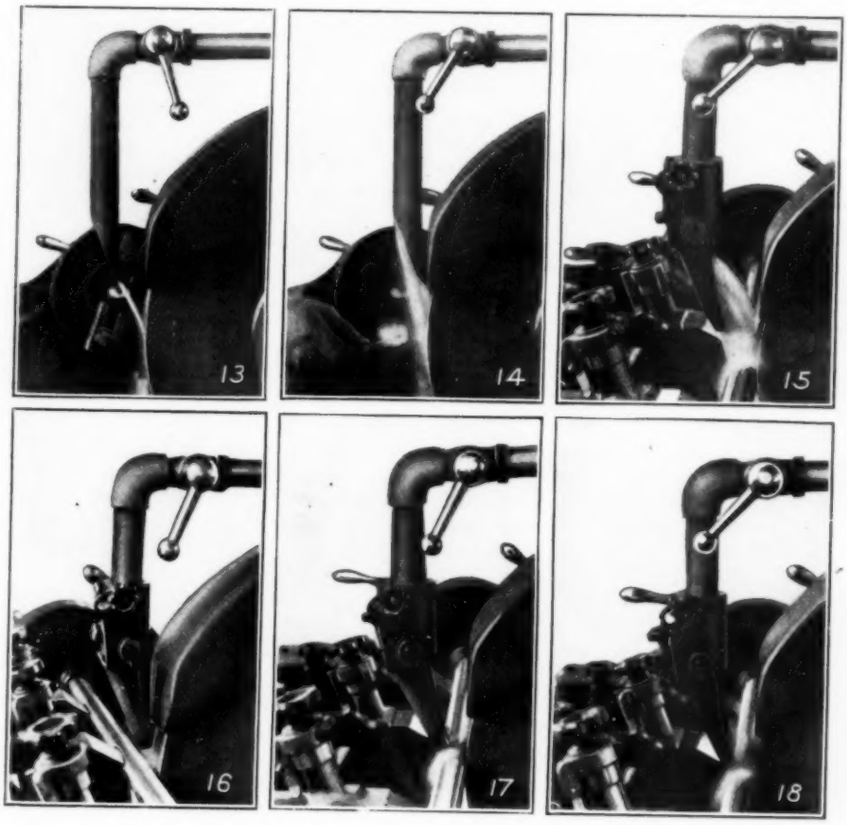


FIG. 5 FIG. 6 FIG. 7 FIG. 8

A VARIETY OF NOZZLES AND THEIR ACTION

effected by variations of the position of the wheel guard and width of wheel face. Different conditions of work require different volume of water while different volumes of water require different angles of delivery to avoid spattering, and a round stream has to be applied differently on some work than a spreading stream. All of these results, however, are very easily obtained by the ordinarily observing man.

A study of Figs. 11, 12 and 15 to 19 will show some of the different adjustments delivering the water to the work. Figs. 11 and 12 were drawn as it was found impossible to photograph water just as it flows on the work and wheel. It will be seen that it is easy to so adjust the nozzle and supply that the work will be engulfed with water and that the wheel face for a considerable space will also be covered with a heavy mass of water. This later feature was true in case of Figs. 15 and 18 but the camera failed to show it clearly. Figs. 16 and 17 show the nozzle in different position and different adjustment of deflector with small amount of water. Fig. 12 shows the collar lowered on the pipe to give a large round stream.



ACTION OF VARIOUS NOZZLES

There are many facts to be known in connection with the use of water with cylindrical grinding if rapid production, accurate work and cleanliness is obtained. Very few users of grinding machines have discovered what is to be known about the application of water to grinding work, for so far, the act of cylindrical grinding has not been given real study by the engineer. He has other problems to consider and has assumed that all that was necessary to do was to let water wet the wheel and that "A stream of water is simply a stream of water as everyone knows." When the engineer learns that everyone does not know, and when the foreman stops to think out the simple facts in order to intelligently instruct the operator, there will be rapid strides in the progress of the art, and great economies will result.

Human nature shows some interesting and amusing sides when it touches the use of water and water nozzles on grinding machines.

Who ever heard of a screw-machine operator who could not adjust the oil pipe to deliver oil on the work at the right place, and who could not turn the oil nozzle so it would not squirt oil on him if he found it doing so? Also who ever saw a shop using screw machines where they did not arrange such oil guards as were needed to protect the operator, and this without comment or complaint?

I have yet to discover a place where such reasoning has been applied to water and the grinding machine, unless the machine was home made, when it has seemed to be all water guards. Who has known of a shop arranging different water nozzles for different kinds of work? Yet this is common when oil is used on screw machines.

Some Amusing Experiences

Many amusing incidents have come under my notice at times. A new man was operating a grinding machine in our own works, and one day he asked in all seriousness for an oil-skin coat. When his trouble was investigated it was found that he was very wet by water that splashed on him owing to the position of the nozzle and angle of the stream against the work. The nozzle was properly adjusted and not a drop of water came over the machine table. This nozzle had convenient adjustments in all directions for this very purpose.

A large concern complained at the expense of rubber suits for the operator, the writer called to see what was the cause of the rubber-suit expense and found the operator clad in coat and high boots of rubber. The floor was spoiled by long soaking in soda water. This operator was in a desperate state of mind; visions of consumption and early death stared him in the face.

He told me a tale of ill health caused by working in wet clothes so long before the company supplied him with the rubber suit, and now he must stand over water on the floor day after day and he had a large family to support.

The nozzle was adjusted and not a drop escaped from its proper boundaries and after some explanations to the foreman, all appeared happy. A short time afterward I called again only to find the rubber suit again in use. Again the nozzle was adjusted and the rubber suit removed.

One foreman removed the pump because he was afraid someone would get water on the machine, and he was certain that it would spoil the machine to wet it. Just how he explained to himself the maker's reson for providing the pump to furnish some forty gallons per minute and a tank to hold a barrel of water, is a mystery.

Another foreman concluded that the water nozzle should be screwed tighter so he took the pipe tongs and screwed it more, thus turning the nozzle back side front. He said he was glad that I called because the machine was not made right, that the water got on the operator badly. In this case about half of the water was directed toward and on the operator.

At another works, they for some unknown reason, turned the nozzle back side front and then tied rags over the nozzle to keep water off from the operator. They had allowed the deflector to be ground away and ruined, but had taken good care of the rags.

A number of users have assumed that water was an unnecessary evil, and have spent good money in a vain attempt to grind dry. If someone will invent a device to thwart such brands of human nature as these, he will prove himself indeed a wizard.

Worcester, Mass. C. H. Norton.

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When Does Copying Become Justifiable?

There is at the present time a widespread and entirely justifiable feeling of indignation among American machine-tool builders at the wholesale copying of their designs which is now going on in Europe, and more especially in Germany.

When one considers all that is involved in placing a new machine tool upon the market, in the way of thought, effort, risk and direct expense, to say nothing of indirect expense in experimental work which frequently precedes the preparation of the designs, there would seem to be nothing in which one ought to have a proprietary right more than the design of new machinery, whether covered by patents or not. One may, however, feel as strongly as possible on this subject, and at the same time recognize the fact that every designer bases his work upon what has gone before, and that, to a large extent, he is indebted to the work of his predecessors.

There was a time when the crank and connecting rod of the steam engine was a new device. It was, in fact, covered by a patent, and the invention of sun and planet gearing, by James Watt, was the outgrowth of the necessity of avoiding infringement. In the field of machine-tool design there was a time when the slide rest and the back gear of the engine lathe were new devices, though whether they were ever covered by patents we do not know. Whether they were so covered or not, there are numerous other standard features of every machine tool which were not so covered, and we may well imagine the indignation of their designers when they were first copied. Today such things have become incorporated in common practice, and are used by all as a matter of course, and without thought on the one hand, or charges of copying on the other.

Where shall we draw the line? To the extent that patent protection obtains it is easy to draw the line at the expiration of the patent, but this fails in the cases of numberless unpatentable features, and, with the practical abrogation of patent protection in foreign countries through the compulsory working clause of patents issued by those countries, it fails again. In any case, the appeal to the patent criterion transfers the question from the field of morals to that of law, and that at best is unsatisfactory.

The question is one which we will not attempt to answer, because we are not able to answer it. We have as much sympathy as anyone can have with American machine-tool manufacturers, whose work is now being simply stolen by the wholesale, but we believe the line indicated cannot be drawn. It is easy to express an opinion in an individual case, and to cover the general question by saying that when a device or feature has become common property it may be used by all, but this only begs the question. In every case it will be found that the first use of the device by someone other than its inventor was a piece of rank copying, and without such first copying the device would not have become common property. The subject is, we believe, one of the most puzzling connected with the machine-building industry.

A Possible Impairment of Capital

The record of the past year of business inactivity shows but a few machine-shop failures. This is a fortunate condition of affairs and one upon which the machine-building industry should be congratulated. As the situation now stands it is merely a question of endurance of the present situation until business activity shall have risen to its former high level. It is to be expected that this point will be reached during a period of time so short, that there will be few if any more machine-shop failures to add to the record of last year.

Yet one phase of the present situation may be studied with profit. During the years of great prosperity and the extension of business, working capital in many instances was largely represented by bills receivable. Business conditions changed and output was reduced; the natural tendency was toward an increased cost of production per unit. Fixed charges and fixed expense burdens were now distributed over a decreased output. In most cases decrease in the cost of material and price of labor was far from sufficient to overbalance or to equalize the proportional increase of expense. Thus total costs were in danger of a wide fluctuation with a tendency upward, and therefrom a decrease of the normal margin between cost and selling price. At the same time a lessened volume of business reduced the number of outstanding accounts, and of these the new accounts represented less proportional profit for the reasons we have pointed out.

With these conditions, the danger naturally arises that the working capital, which was represented largely by bills renewable, will be reduced beyond a safe limit unless watchfulness and care are given to this phase of the financial situation. Generalizing, it is the danger of an impairment of capital due to the necessity of keeping a plant in at least partial operation during a long period of business inactivity, and to the reduction in the amount of outstanding accounts. We do not know of any firm where such a situation has developed or is about to develop, and sincerely hope that such conditions may be avoided. Yet the danger is a real one, and careful watchfulness of the financial situation should be continued so that there may be ample capital for business needs when business activity returns.

New Tools and Machine Shop Appliances

Showing New Ideas in Machine Shop Equipment That Make It Possible To Do Better Work at a Reduced Cost

THE LATEST INFORMATION

Combination Grinding Stand

This combination is especially adapted for pattern shops and other woodworking establishments as it contains all the necessary sharpening devices for the tools used. The lower spindle carries two oilstone wheels of different grades, which are kept saturated with kerosene to keep them

COMBINATION GRINDING STAND

clean and sharp. This hardly shows when the wheels are standing still, but is forced out when in motion, and after being thoroughly saturated they require very little oiling from time to time.

Above these on the other spindle is a grinding cone for sharpening the inside of gouges, and around this a leather wheel for stropping chisels either on its face or edge. At the other end of this spindle is a regular grinding wheel of 8 or 10 inches in diameter, and by using a narrow wheel, circular saws and similar tools can also be sharpened here. A tool-holding attachment is provided for those who desire it and is hung from the table, as shown. This machine is built by the Mummert, Wolf & Dixon Company, Hanover, Penn., and can be supplied either for belt drive, as shown, or with a different base containing a motor and starting box.

A Very Large Drawing Press

The Ferracute Machine Company, Bridgeton, N. J., has recently completed a very large press for drawing up sheet-metal coffins of either copper or steel for the Montross Casket Company. These are drawn in one piece, as can be seen, the corner being, of course, a second operation. The caskets are 6 feet long, 20 inches wide and 12 inches deep.

This might be called twin construction, as it has the appearance of two presses, each cast-iron column being reinforced by two 4¾-inch steel rods. The ram is double and the pressure is distributed over four points by pitmans. These four pitmans are geared together to move in unison, all being connected to a hand wheel so arranged that one turn gives an adjustment of 0.001 inch. An electric motor is connected in the train for giving rapid adjustment through a considerable distance.

There are two rams, the outer moving down with the inner ram for about half its stroke and being stopped by the blank holder and lower die coming together. It is locked at this point by four toggle levers which transfer the pressure to the frame of the press instead of to the main shaft as in a cam press. While this device has been used by this company on small presses it is believed to be a new application to a large drawing press.

With this construction the whole outer ram may be quickly removed, when it becomes a single-acting press, a very convenient feature. The machine is triple

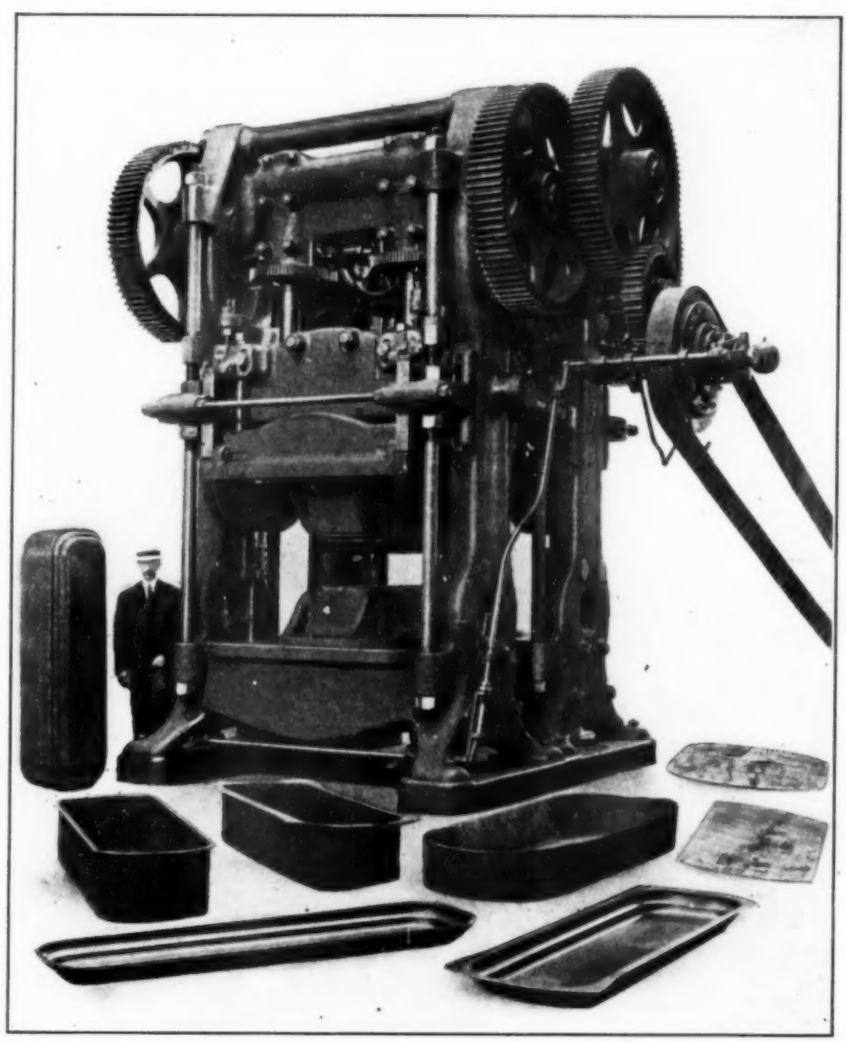


FIG. 1. PRESS FOR DRAWING SHEET-METAL CASKETS

geared, all cut from the solid, the five large gears being 5 feet in diameter and 10-inch face. The ratio is 200 to 1. The stroke of the inner ram is 28 inches, while the outer ram may be varied up to 24 inches, but, adjusted as shown, the stroke is 14 inches, the casket being but 12 inches deep. The press weighs nearly 100 tons and can exert a pressure of 1000 tons.

The first operation cuts the blank, the second draws the shell 9½ inches deep, the next re-draws it to the full depth of 12 inches, the fourth and fifth, trim and form the edge. Bath tubs, metallic boats,

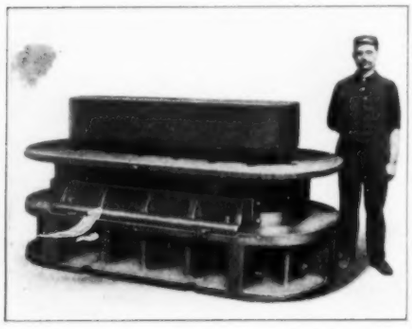


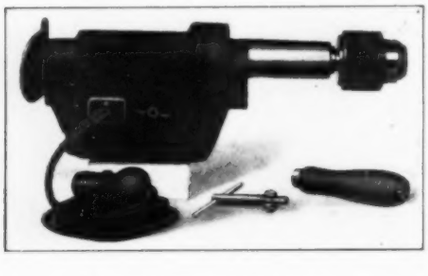
FIG. 2. DIES FOR RE-DRAWING PROCESS

automobile bodies and similar articles of steel or copper can also be drawn in such a press.

The dies for such a piece of work must, of course, be very large, but careful designing has kept them smaller than might be imagined. The dies shown are used for drawing to the final depth. The lower die rests on the floor, the next die or blank holder being above this and the punch is suspended over them all.

Electrical Breast Drill

This shows one of a new line of portable electric breast drill, recently brought out by the Willey Machine Company, of Jeffersonville, Ind. It has been their endeavor to combine simplicity and durability, so that only two gears are used, these being cut from bar steel. The bearings have removable phosphor-bronze bushings.



ELECTRICAL BREAST DRILL

All electrical connections are attached to the main or central member of the machine, and are not disturbed when the machine is taken apart for any purpose. By removing two nuts the entire machine can be taken apart, and put together again by any ordinary mechanic, no electrical knowledge being necessary for this. A snap switch is located on the side of the machine convenient for starting and stopping the drill. The side handle can be quickly attached or detached at the option of the operator. Special attention has been given to ventilation to insure cool running, a system of air ducts in the armature being employed similar to those found in all large motors.

The tool is made in four sizes, having a maximum capacity in steel of ¼, ⅜, ½ and ¾ inch, the latter having two speeds. The motors are wound for either direct or alternating current, and for any voltage up to 250.

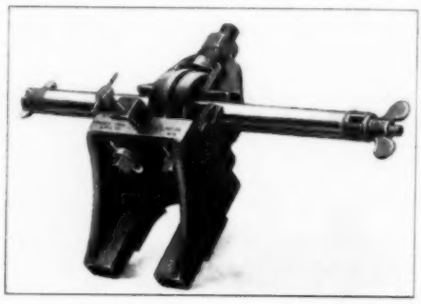
Heavy Duty Radial Drills

This machine has been designed to enable the new high-speed drills to be used to their full capacity, which means that both additional rigidity and power have been made necessary. The speed box has been made to transmit all the power necessary, and is so arranged that the gears may be thrown in or out at high speed with very little shock. Tests both in drilling and tapping, which include drills from ½ to 3½ inches in diameter and from 4- to 6-inch pipe taps give a good indication of the power transmitted, as in the latter case this ran up to 9 horsepower. This speaks well for the frictions in the speed box, which are of the double-band type and evidently give ample power.

The spindle has 24 changes of speed, the range depending on the size of the machine, which is being built with arms of 4, 5, 6 and 7 feet. These drills are built by the American Tool Works Company, Cincinnati, Ohio.

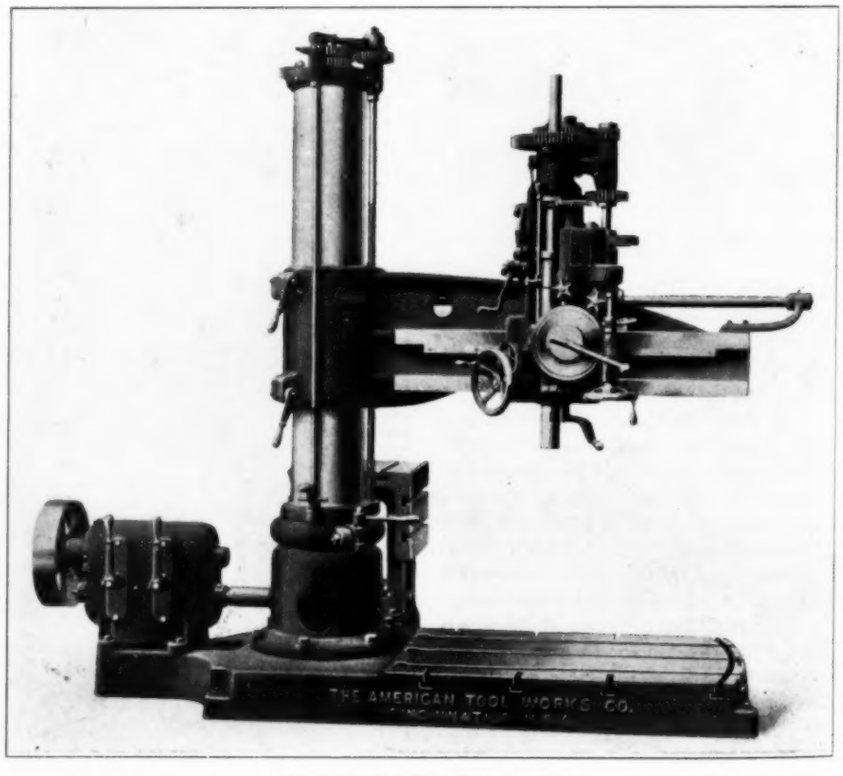
A Boring Bar Holder

The illustration shows an adjustable boring bar holder for the engine lathe. It



A BORING BAR HOLDER

consists of an angle plate which is secured to the tool slide of the lathe. Mounted on the vertical member of the angle plate is a casting having a V at each end and a stud in the center which passes through a yoke. A single nut clamps the yoke on the boring bar. The part which clamps the boring bar can be set to any desired hight by the adjusting T-screw shown.



RADIAL DRILL FOR HEAVY DUTY

This holder will take any size of bar from ¼- to 1¼-inch diameter and is made in two sizes for lathes 14 to 20 inches, and 20 to 30 inches swing by the Krieger Tool and Manufacturing Company, Chicago, Ill.

A Die Milling Machine

This is a milling machine for the maker of punching and trimming dies for both forgings and sheet metal work. The inverted spindle holds the milling

MILLING MACHINE DIES FOR PRESS OR DROP FORGE

cutter under the work, which is held in the opening of the heavy universal carriage. This is controlled by hand wheels and can be readily moved in any direction so as to follow the outline of the die.

The spindle has a cutter-holding device which combines rigidity with ease of changing cutters. When released the cutter is forced out. Four collets, from ⅜ to ¾ inch are furnished with the machine. It is made by the Billings & Spencer Company, Hartford, Conn.

Flather 30-inch Boring Mill

The special feature of this machine is the moving cross-rail on a mill of this

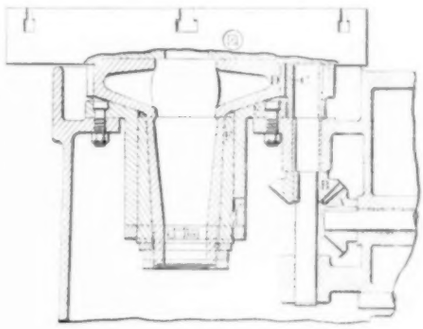


FIG. 3. DETAILS OF THE DRIVE

size. This has a movement of 17½ inches, supporting the turret at all points. The cross-slide has a travel of 23 inches while the turret slide moves 17 inches and can be swiveled.

The feeds are all handled through the gear box at the side of the machine and are usually arranged to give 7, 8, 9, 10, 11½ and 12 to the inch so as to cut threads or chase scrolls as desired. The small clutch lever at the end of cross-rail multiplies these feeds by three, giving from 21 to 36. This ratio can be changed by changing the gear at the front of the gear box, this cover being easily removed for the purpose by taking off two nuts as shown. All feeds are reversible.

The feed of the turret is controlled by an adjustment on end of cross-rail, including an automatic trip which acts as a vertical stop gage and is used in connection with the graduated disk shown. The turret slide is counterbalanced, the rope running over the single arm which has a ball thrust bearing so that it swings easily. The cross-slide movement is by the hand wheel at the back. The turret is a 10-inch pentagon with 2¼-inch holes.

The drive is through bevel gears *A* and *B* in Fig. 3, to the spur pinion *C* driving the table-support *D* which has gear teeth cut in it. This bears on *E* and is centered

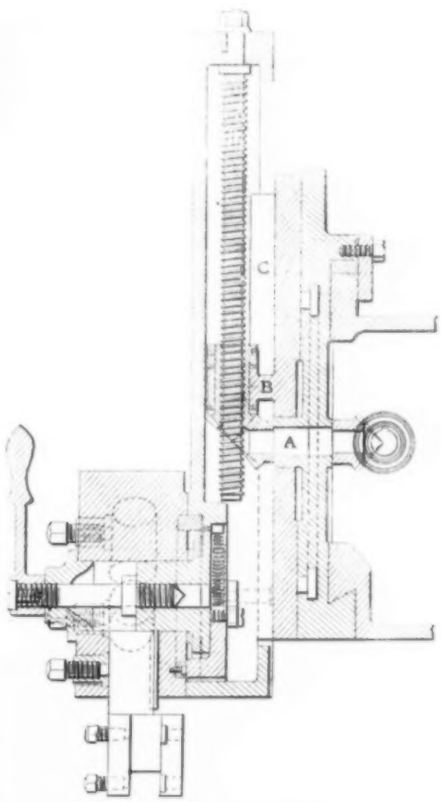


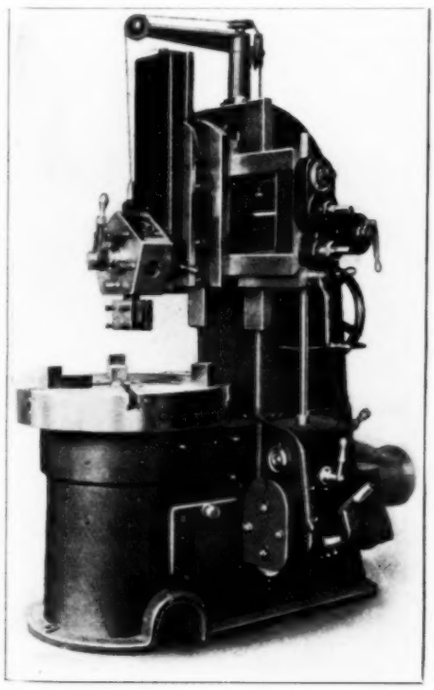
FIG. 4. THE TURRET SLIDE

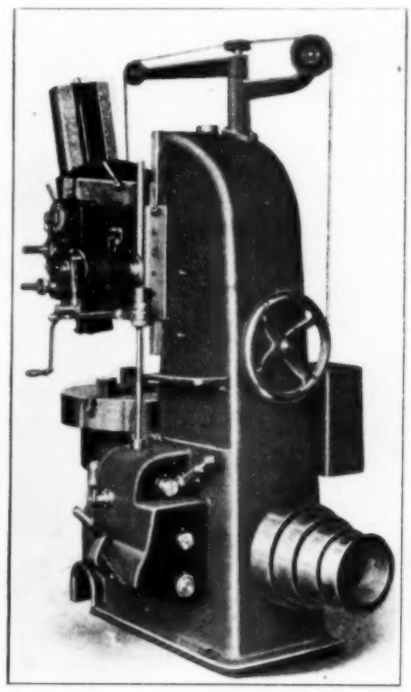
by the taper bushing *F* which also takes all side strains. This is adjustable by the ring nuts at the bottom.

The four-step cone gives 16 speeds to the table through back gears and a two-speed countershaft.

Instead of using a rack for the vertical feed of the turret slide there is a stationary screw having a quick lead as shown in Fig. 4. The nut *B* is held in the support shown and is turned by the bevel pinions in shaft *A* which in turn is driven from the feed rod at the back. This view also shows the details of the cross-slide and the turret.

The floor space required is 47x68 inches, it is 88 inches high and weighs about 5300 pounds. This is made by the E. J. Flather Manufacturing Company, Nashua, N. H.





FIGS. 1 AND 2. FRONT AND REAR VIEW OF 30-INCH BORING MILL

Speed Change for Planers

The Cincinnati Planer Company, Cincinnati, Ohio, has been testing out a two-speed drive and is now ready to recommend it to its customers. The only change from the regular machine is one additional pulley on the driving shaft and a nurled handle on top of the shifting mechanism which is shown in both positions in Figs. 1 and 2. The first shows it in position for high speed while the second shows the belt shifter at the extreme right for slow speed.

Fig. 3 shows the two-speed countershaft and with belts in the position indicated, is returning the platen, pulley 6 (which it will be seen has a heavy rim for its flywheel effect) driving return pulley 8 and the other belt running loose on 9.

Shifting both belts to the right, the return belt goes on to loose pulley 7, and the forward belt from 5, which is driven by the high-speed pulley 2, runs on 8 and drives the planer at the highest forward speed, in this case 50 feet per minute.

Changing the nurled handle so as to throw in the slow speed, the forward belt is driven by pulley 4, which is loose on the countershaft but driven by a slower speed belt from the line shaft on the left or crowned portion, while the straight part, next to 5, carries the driving belt. Forward speed is obtained with the belt from 4 to 10 and the reversal is the same as before.

This is so simple that no further description or details seem necessary and it will be clear that different speed changes can be had by changing the driving pulleys on the line shaft.

Controller for Machine Tool Motor

The control of a motor on a machine tool is hardly less important than the motor itself and simplicity and durability are the aims of both makers and users. This is of the self-contained, drum type, containing both the starting resistance and the speed-regulating devices. The illustration shows the front of the controller and also gives an idea of its size. The starting resistance coils are in the lower half, while the field-regulating resistance coils are at the back, and are four in number. These are divided into 20 steps, and provide a range of 2 or 3 to 1 as desired. All resistance coils are easily removable.

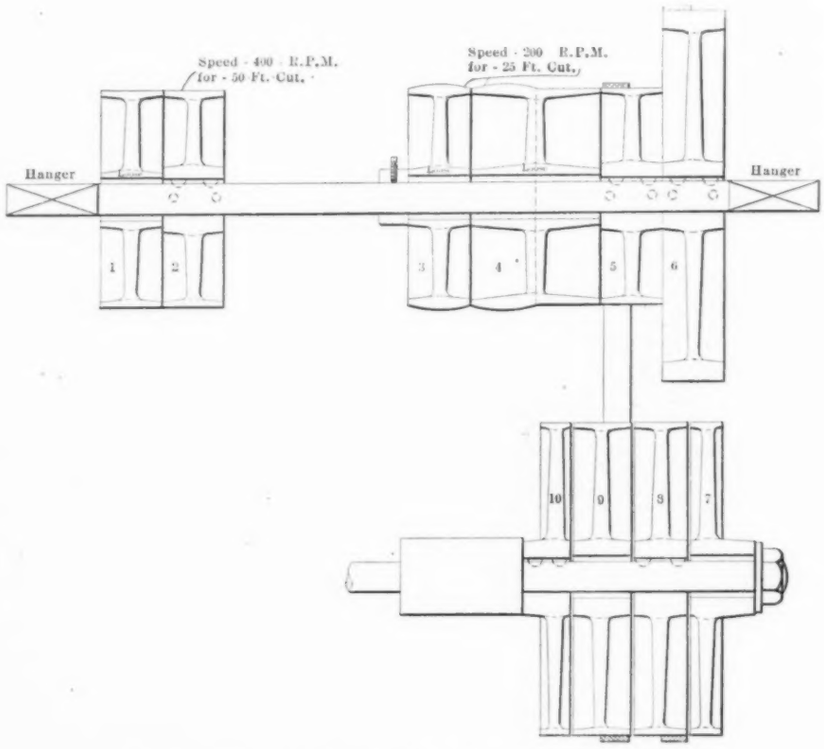


FIG. 3. COUNTERSHAFT AND BELTS FOR TWO-SPEED DRIVE

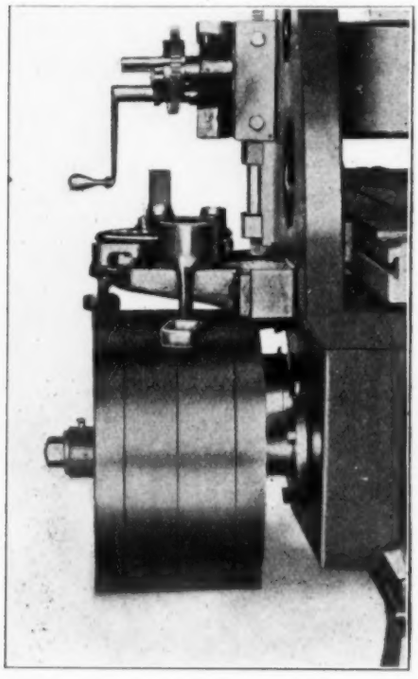


FIG. 1. HIGH-SPEED POSITION

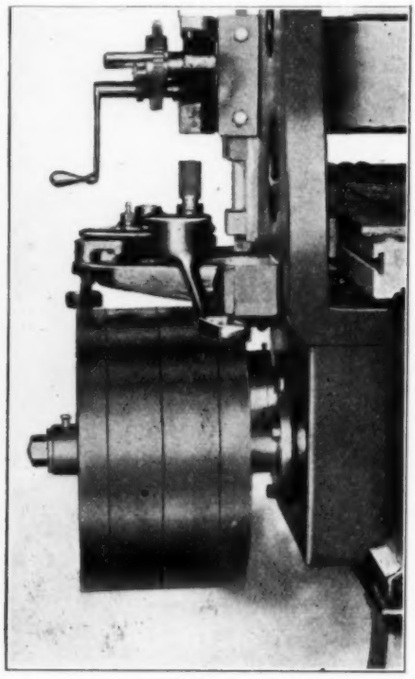
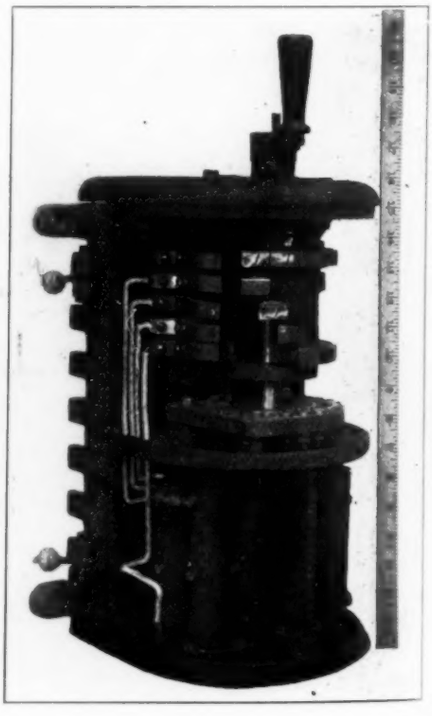


FIG. 2. LOW-SPEED POSITION



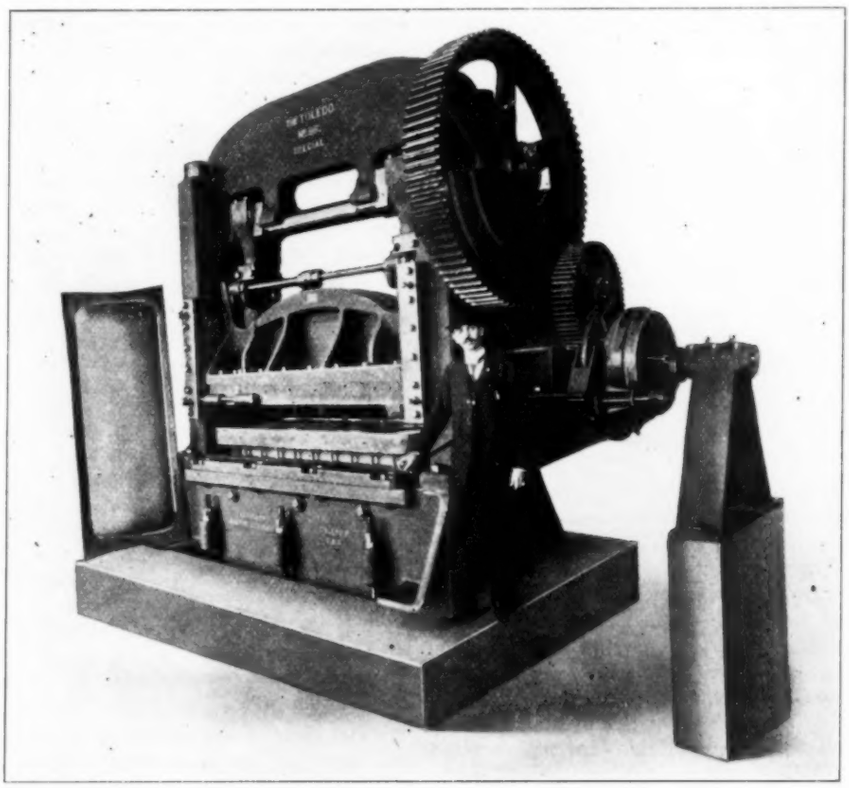
CONTROLLER FOR MULTIPLE-SPEED MOTOR

These controllers are made for either reversible or non-reversible motors from 1 to 7½ horsepower and for 110- or 220-volt circuit, by the Cutler-Hammer Manufacturing company, Milwaukee, Wis.

Drawing Press with Adjustable Dies

This press is for making covers to metallic caskets and similar work, drawing up a cover, as shown at the left, in 10 seconds. The dies, which are double acting, are made adjustable for several lengths of covers and can be changed without removing either the upper or lower dies from the press.

The drawing or pressure ring, shown in the illustration, rests on the studs or pins around the interior of lower die and on which the flat sheet is placed. This controls the sheet being formed by means of the heavy spring pressure attachment which is placed in the interior of the press bed. This pressure is obtained from six heavy springs, three being shown in front of the machine, so arranged as to be easily accessible. The friction clutch enables the operator to handle the ram easily or to stop it at any desired part of the stroke. The press is 102 inches between uprights, 50 inches from front to back, and has a stroke of 12 inches. It weighs 85,000 pounds, and is built by the Toledo Machine and Tool Company, Toledo, Ohio.



DRAWING PRESS WITH ADJUSTABLE DIE

A Riveter with an Hydraulic "Holder On"

This press or bulldozer is made in two styles, or with an attachment for riveting, as shown in Fig. 1. In this style it is a horizontal-crank riveter with the additional feature of an hydraulic "holder on" which maintains the desired pressure at all times and allows for any variation in the thickness of the stock or in the size of rivet. The accumulator, shown at the back, maintains any desired pressure by allowing the holder on to recede when the stock is thick or the rivet large, or advance when the case is reversed.

They can be driven in any way desired, the control being by a pin clutch actuated by the foot treadle. The machine makes one revolution and stops automatically.

The machine is adapted for structural work, such as angle-iron frames, and similar pieces. The rolls at each side act as guides and can be adjusted to different hights. It can be transformed into a bulldozer with very little trouble. Fig. 2 shows a plain bulldozer built on similar lines. These are made by Logemann Brothers, Milwaukee, Wis.

Considerable interest has manifested itself in engineering and agricultural circles of late with respect to the part the motor plow is destined to play in the farming industry. Some tests have been made with this latest type of farming implement and it has been found to be an improvement over the steam plow, with the expectation that when fully developed the motor plow will prove a more expeditious and no doubt more economical means of plowing the ground, particularly in the sections where the farming districts cover extensive areas.

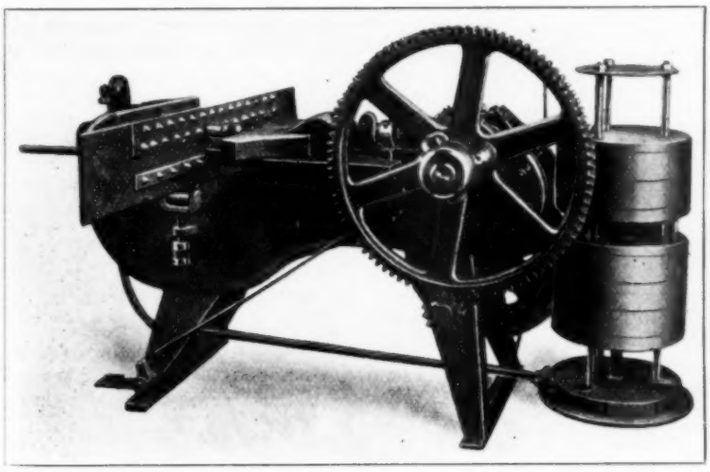


FIG. 1. RIVETER WITH HYDRAULIC "HOLDER ON"

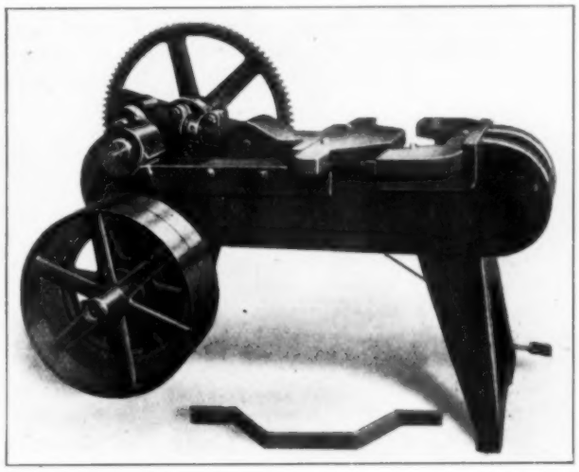


FIG. 2. PLAIN BULLDOZER

The Lawrence Industrial School

By William H. Dooley*

The Lawrence Industrial School, Lawrence, Mass., opened October 19 with a registration of over 900 students. It resumes its classes with prospects of another year of success. This school is the only independent industrial school in this State with independent buildings, and with an independent board of five trustees. It was established under the Industrial School act, and opened last year with evening and day classes for those already engaged in the trades. This school represents a new phase of education; namely, practical education by which the industrial worker may meet his daily needs. Industrial superiority depends upon industrial training and education, and this training and education can be accomplished best, not by the methods of the mill and shop, but with those methods supplemented by industrial education. It was such a school that Lawrence lacked until a few years ago.

As principal, I made an extensive study of industrial-school methods in nine European countries. The result is that Lawrence and the surrounding cities and towns, are now provided with the means of educating, in a systematic manner, their large number of textile and metal workers. No entrance examinations are held, the only qualification being that the applicant for admission be an operative. The school is free. Textbooks are edited by the instructors, and printed by the commission. The problems, drawings and notes come from the shop, so that the school keeps in touch with the industries. These notes and problems are obtained by means of a question box. The instructors are practical men, working in the industries and conversant with the needs of the operatives.

A certificate is awarded to each person completing a course. Day classes are formed for the convenience of those who are unable to attend the evening sessions. The school is in a position to compete with any of its kind; over $32,000 is represented in its uptodate woolen, worsted, cotton and steam machinery.

Classes in the following subjects will be formed for both day and evening pupils: Woolen and worsted spinning, woolen and worsted weaving, woolen and worsted finishing, dobby and jacquard weaving, cotton spinning, cotton weaving, loom fixing and loom calculations, mill arithmetic and mill bookkeeping, elementary and advanced textile designs, elementary and advanced cloth calculations, industrial and commercial electricity, steam engineering for firemen, steam engineering for engineers, arithmetic for firemen and engineers, blueprint reading, machine drawing and arithmetic for machinists, shop arithmetic, industrial and commercial chemistry, experimental and practical dyeing and dressmaking for working girls.

The courses of woolen and worsted manufacturing are arranged to meet the daily needs of those working in these industries. Instruction is given in all the various processes employed in adapting the wool fiber to cloth; namely, sorting, scouring, carding, combing, spinning, designing, weaving, dyeing and finishing.

The Cotton Course

The cotton courses are designed to meet the needs of the men working in these industries; to make better workers of them and to train them to think and take an interest in their work. If sufficient numbers register, classes will be formed in picking, carding, drawing, roving, spinning, combing, designing and weaving. In connection with this work a course in knitting is offered. The equipment of the department is of the best uptodate cotton machinery.

Experimental Laboratory, Dye House and Industrial Chemical Laboratory

This work is carried on in a building located in an ideal spot for a dye house. It is situated on the banks of the Merrimack just above the falls, away from the class rooms and dwellings. It is modeled after one of the most practical experimental laboratories in the country.

Besides lectures and recitations upon dyeing, students will perform careful and systematic experiments as to the nature of the various dyestuffs and mordants, their coloring properties, their action under various circumstances, and conditions under which they give the best results. The more representative dyestuffs of each class will be applied to cotton, wool and silk, and each student will be obliged to enter in an especially arranged sample book a specimen of each of his dye trials with full particulars as to conditions of experiment, percentage of compounds used, time, temperature of dye bath, etc.

For convenience and economy most of the dye trials will be made upon small skeins or swatches of the required material, but from time to time students will be required to dye larger quantities, in full-sized dyeing machines under conditions of a practical dye house.

By use of a small printing machine the principles of calico printing are illustrated, and the practical side of the subject will be studied with dyeing machines, vats, etc.

In industrial chemistry particular attention is paid to those subjects which are of especial interest to the textile worker, as oils, soaps, gas and the coal-tar industry; the manufacture of important chemical compounds, such as the common acids and alkalies, bleaching powder, various mordants, etc. Cabinets containing the various dyestuffs, chemicals and by-products of wool grease are on exhibition in the dyehouse and students have an opportunity to study them.

Steam Engineering and Electricity

One of the strongest departments of the school is the course in steam engineering and electricity. The course consists of lectures by practical men who are specialists in their respective branches; arithmetic and practical mathematics for engineers, firemen, etc., and laboratory practice in steam engineering. The steam engineering laboratory is one of the best equipped laboratories in the country. The equipment consists of different types of boilers, steam-heating apparatus with appendages, different pumps in sections, sectional valves and gages, all the boiler accessories, steam engines, a generator and other machines. In addition to these, pictures, blueprints and sketches of the above apparatus and other machines are on the wall for careful study. All the lectures, classes and demonstrations are carefully planned to meet the needs of those working in the trades. Classes are formed afternoons for those working nights, and evening sessions are conducted for those laboring days. This is the first free engineering laboratory in this country.

*Secretary of the commission and principal of the school.

Personal*

E. E. Bartlett, of Boston, Mass., sailed on the "Lusitania" on October 14, for a six weeks' trip abroad.

Fred A. Geier and family returned from an extended trip to Europe in time to attend the convention of the National Association of Machine Tool Builders.

Peter Severin Steenstrup, general sales manager of the Hyatt Roller Bearing Company, will make his headquarters in the Majestic building, Detroit, Mich., after November 1.

Bernhard Gustafson, formerly with the United Printing Machinery Company, has opened an office as consulting engineer at 45 Broadway, this city, where he will make a specialty of printing machinery.

Charles Phillips, who for several years was the tool expert for Hoffman & Billings, of Milwaukee, Wis., has recently been made manager of the shop of the Manufacturers' Equipment Company, Chicago, Illinois.

H. P. James, formerly electrical engineer of the Bryant Electric Company, has recently taken charge of the new line of push-button specialties manufactured by the Cutler-Hammer Manufacturing Company, Milwaukee, Wis.

At the convention of the National Asso-

*Items for this column are solicited.

ciation of Machine Tool Builders it was announced that C. F. Hilker, president of the Hamilton Machine Tool Company, had, with Mrs. Hilker, met with a runaway accident, Mrs. Hilker's injuries being serious.

R. H. Palmer has taken the position of instructor in foundry practice at the Worcester Polytechnic Institute for the ensuing year. Mr. Palmer was formerly superintendent of R. H. Hoe & Co.'s foundry, and more recently in charge of foundry work for a Western railroad.

G. K. McMullen, for over ten years sales manager of the Fox Machine Company, Grand Rapids, Mich., has tendered his resignation to take effect November 15, and will at that time engage in business for himself, announcement of which will be made later.

Paul W. Abbott, of the Lowell Machine Shop, Lowell, Mass., has resigned his position as assistant foreman of their screw-machine department and has accepted the position of foreman of the screw-machine department of the Adder Machine Company, Wilkes-Barre, Penn.

S. R. Stockvis

S. R. Stockvis, director and chairman of R. S. Stockvis & Sons, Rotterdam, Holland, with branch houses in Brussels and Java, died recently, having passed his 80th-birthday mark.

This trading house has been an important one in the machine-tool industry, having been founded by R. S. Stockvis, father of the recently deceased. Although advanced in age, Mr. Stockvis took a very active part in the affairs of his company until a short time before his death, and the company's management now devolves upon his two sons and three nephews, who have been actively engaged in the business.

Business Items

Holroyd & Co., Waterford, N. Y., have sent us a series of pretty postal cards which they use in acknowledging orders.

The corporate name of the Dodge Coal Storage Company has been changed to the J. M. Dodge Company. James M. Dodge, chairman of the Link-Belt Company, president.

The Anglo-Newfoundland Development Company, of Grand Falls, Newfoundland, has awarded the contract for heating its buildings, now under construction at Grand Falls, to the American Blower Company, Detroit, Mich.

Peter Hooker, Ltd., has purchased the entire plant, stocks, patents and good will of the Newall Engineering Company, Warrington, England, manufacturers of limit gages, measuring machines, micrometers, etc., and will operate the company as a department of its own business at its works, Blackhorse Lane, Walthamstow, London, England.

The Hyatt Roller Bearing Company, Newark, N. J., has opened an office in the Majestic building, Detroit, Mich., which will be the headquarters of its general sales manager, Peter Severin Steenstrup. This office, in the heart of the motor car industry, has been established in order to permit closer attention to the company's increasing business in that particular line.

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The Manville Brothers Company, 27-33 Benedict street, Waterbury, Conn., has purchased from Frederick E. Cross, of the Cross & Spiers Machine Company, Waterbury, Conn., all of the patterns, drawings, etc., of the different lines of machinery and presses that it has been manufacturing. In the future the Manville Brothers Company will make these lines of work and Mr. Cross will be connected with it as a special representative.

The Lumen Bearing Company, of Buffalo, N. Y., has begun the manufacture of die castings in Lumen bronze alloy, to an accuracy of one thousandth of an inch. The Lumen bronze used is their well known bearing metal with compression strength of 80,000 pounds per square inch and a tensile strength of 35,000 pounds. These castings are offered in competition with bronze and other alloys only when these alloys are adapted to ordinary commercial usage.

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Trade Catalogs

Grant-Hoover Ball Company, Merchantville, N. J. Catalog of steel, brass, bronze and cast-iron balls. 13 pages, 3½x6 inches.

Weber Gas Company, Kansas City, Mo. Brochure No. 58, describing engines and producers and showing installations. 4x8½ inches.

Northwestern Expanded Metal Company, Chicago, Ill. Booklet describing Kno-burn metal plastering lathe. Illustrated, 3½x6 inches.

The Gas Machinery Company, Cleveland, Ohio. Bulletin describing Wile gas producers for non-bituminous fuels. Illustrated, 14 pages, 6x9 inches.

Whiting Foundry Equipment Co., Harvey, Ill. Booklet illustrating cranes and other equipment furnished various railroads. 8 pages, 8x9 inches.

Halcomb Steel Company, 79-81 South Jefferson street, Chicago, Ill. Booklet describing tool steels. Illustrated, 16 pages, 3½x6½ inches, paper.

A. Allan & Son, 486 Greenwich street, New York. Bulletin No. 11, descriptive of Allan anti-friction metal. Illustrated, 32 pages, 6x9 inches, paper.

The Carlyle Johnson Machine Company, 356 Asylum street, Hartford, Conn. Catalog D describing friction clutches. Illustrated, 36 pages, 4½x7 inches, paper.

Cushman Electric Company, Concord, N. H. Catalog of Cushman variable-speed motors, variable-speed motor headstock drives and compound starting and regulating rheostats. Illustrated, 16 pages, 4x6 inches, paper.

Business Opportunities

The Northwestern Consolidated Iron and Steel Company, Burlintgon, Iowa, manufacturing hardware specialties, will erect a new plant.

E. D. and A. F. Cronk, Utica, N. Y., are having plans prepared for a new building to be used as a machine shop for electrical repairs.

The Davis Manufacturing Company, Milwaukee, Wis., will erect a new factory building. The company manufactures gasolene engines.

The South Houston Lumber Company will establish a sawmill at South Houston, Texas. C. S. Woods, 931 Franklin street, Houston, manager.

Crosby Folding Company, Jonesboro, Ark., has been incorporated to manufacture folding egg cases, chicken coops, etc. Grant Green, president.

The Fuller-Ames Company, of Chicago, Ill., will move to Joliet, where a new plant will be erected for the manufacture of its railway specialties.

The Mark Manufacturing Company, making iron pipe and well supplies, is planning, it is said, extensive additions to its plant in Zanesville, Ohio.

The Peoples Gas Light and Fuel Company, Minneapolis, Minn., has been organized to manufacture gas. It is said a $1,000,000 plant will be erected.

The Sylvester Company, whose plant at Danvers, Mass., was destroyed by fire, has decided to rebuild. The company manufactures spikes and bar iron.

The Virginia Air Line Railway Company will erect roundhouse, car sheds, etc., at Gordonsville, Va. Walter Washbaugh, Charlottesville, chief engineer.

The Haas & Polde Carriage Company, St. Louis, Mo., is said to be planning erection of building to be equipped for the manufacture of automobiles.

The Union Metal Works, Chelsea, Mass., whose plant was recently burned, will rebuild at once. The company manufactures copper and brass work.

The sawmill and planing mill, of Frey Brothers & Company, Lafayette, Ind., were destroyed by fire. Loss $20,000. The plant will be rebuilt.

The Baltimore (Md.) Mutual Stamping and Manufacturing Company has been incorporated and will erect building for the manufacture of metal ceilings, etc.

Contract has been awarded for the rebuilding of mill No. 1, of the Uncas Paper Company, at Thamesville, Conn., which burned several months ago.

The Isthmian Canal Commission, Washington, D. C., will receive bids up to 10:30 a.m. November 16 for three rapid unloading cranes as per Circular No. 475.

It is reported that the Everitt-Metzgar-Flanders Company, Detroit, Mich., will erect an addition for the purpose of increasing its output of automobiles.

The roundhouse of the Southern Pacific Railway at Beaumont, Texas, destroyed by fire October 5, at a loss of about $50,000, will be rebuilt immediately.

The Anderson Electric and Manufacturing Company, McPherson, Kan., has been incor-

porated for the purpose of manufacturing a patented lock-out switch.

The Goshen (Ind.) Motor Works has been incorporated with $25,000 capital. The company will manufacture gasolene engines and motors, boilers, automobiles, etc. O. D. Ihrig, G. B. Kessler are among the directors.

A new can factory with a capacity of 250,000 cans daily is to be erected at Norwood, Cincinnati, Ohio. O. C. Huffman, president of the Virginia Can Company, Buchanan, Va., will be at the head of the new concern.

The Manitowoc (Wis.) Seating Works Company has been incorporated to manufacture school and church furniture. M. H. Murphy, formerly general manager of the American School Furniture Company, is at the head of the new concern.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open the following bids: November 3—Hack-saw blades, differential blocks, chain blocks (schedule 501), bolts, cap screws (schedule 493), twist drills (schedule 495), steel (schedule 502), pipe and fittings (schedule 503), angle bars, track bolts, spike ties (schedule 466). November 10—Bolts and nuts, hose (schedule 469), ventilating fan (schedule 468), pneumatic piston drill (schedule 523), hoisting engine (schedule 510), electric hoist (schedule 529), hack-saw blades, machine screws (schedule 524), steel (schedules 521, 525). November 17—Electrical supplies (schedule 471), drill press, hack saw, milling machines, planer, 20-inch shaper, 14-inch shaper (schedule 511), polishing and buffing equipment (schedule 513), bar shear (schedule 512). November 24—Beam bending press, die sinking machine, file sharpening machine, engine lathes (schedule 489), drilling machines, grinder head, shaping machine, shafting, pulleys, belts, etc. (schedule 488), annealing, hardening furnaces (schedule 490), facing press (schedule 518).

Want Advertisements

Rate 25 cents per line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Caliper list free. E. G. Smith Co., Columbia, Pa.

High speed machinery designed. Fred L. Fay, Wilmington, Del.

Steel case hardened; modern methods. Boston Gear Works, Norfolk Downs, Mass.

We buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Hand power bending tools, labor-saving, money-making. Estep & Dolan, Sandwich, Ill.

Braze cast iron with Universal Fluxine, $.50 per pound. Universal Fluxine Co., Urbana, Ohio.

Machinery built to order. Up-to-date plant. Write Brunswick Refrigerating Co., New Brunswick, N. J.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Mechanical drawings correctly and quickly made. H. C. Karson, Room 123, 39 Cortlandt St., New York.

Machines designed; automatic, special. Practical working drawings. C. W. Pitman, 3519 Frankford Ave., Philadelphia, Pa.

Special machinery accurately built. Screw machine or turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Don't spend a dollar on patents until you have read our free book. Benjamin & Bassett, 514 F Street, Washington, D. C.

British patents law. Factory sites between Liverpool and Manchester with water, coal, electric power, railroad, tramcars. Hulton Park, Bolton, England.

Want to correspond with manufacturer having equipment for economical production of high grade small and medium size gas engines. Box 578, AMERICAN MACHINIST

Special machinery and duplicate machine parts built to order; tools, jigs and experimental work; complete modern equipment. MacCordy Mfg. Co., Amsterdam, N. Y.

Cost reducing machinery designed and built. Guaranteed per cent. on investment. Send sample or sketch of work and cost of manufacture. Remington M'f'g Co., Fitchburg, Mass.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMERICAN MACHINIST.

Machinery built to order and by contract; special parts made; gear cutting, automobile and pattern work, punch press and screw machine work, tools, dies, etc. Blair Tool and Machine Works, West and Morris Sts., New York City.

U. S. patent on a novel tool for making washers at one operation, for sale. It is the only tool in existence. Washers can be made of all soft materials, as well as of fiber, brass and iron. From one to five thousand washers can be made in an hour with this hand operating tool. Address A. Zidovec, 19 Pine Place, San Francisco, Cal.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

MARYLAND

Mechanical expert, practical, inventive and systematic, desires responsible position. Box 551, AMERICAN MACHINIST.

Superintendent or works manager, practical mechanic with executive ability and capacity to handle a large plant. References. Box 562, AMERICAN MACHINIST.

MASSACHUSETTS

Who wants a boss toolmaker; 20 years' experience. Box 530, AMERICAN MACHINIST.

MICHIGAN

Responsible situation wanted, by party at present engaged as chief draftsman of tool department with large automobile concern. Age 32; college graduate with considerable shop and drafting room experience. A-1 designer of special and automatic machinery and machine tools. Also experienced in structural work and mill design. Box 584, AM. MACH.

MISSOURI

Mechanical and construction engineer of initative and executive ability, with good business experience selling and shop work, desires to communicate with interested parties having any opening for a man of this description. Has been connected with some of the foremost mining and engineering organizations East and West. Present salary $5,000 per year, under contract until January 1. Desires to locate permanently with suitable firm, investing with them in the enterprise if satisfactory. Box 588, AMERICAN MACHINIST.

NEW YORK

Designer with eleven years' experience on automatic machinery. Box 560, AMER. MACH.

Mechanical draftsman with general technical and practical training, age 36, desires position. Box 596, AMERICAN MACHINIST.

Position as superintendent or general foreman; mechanical expert, practical and technical training; age 37 years. Box 595, AM. M.

Mechanical engineer, with 8 years' workshop experience and 7 years in drafting room (mostly on machine tool work), wants position as salesman. Box 590, AMERICAN MACHINIST.

First class mechanical draftsman and designer wants situation in New York City. Special machinery or automobile work preferred. Salary $21.00 per week. Best references. Box 592, AMERICAN MACHINIST.

Designer and draftsman, technical man, age 30, experienced in mechanical movements, jigs and dies, boiler work, etc., also practical machinist, desires position. Box 582, AM. MA.

Draftsman, college education, one year shop, 6 years' drafting experience, desires field position; experienced in power plant equipment; salary moderate. Box 558, AMERICAN MACHINIST.

Harvard graduate, mechanical engineer (25), desires position with reliable automobile or marine engine firm. Business and shop experience. Technical writer. S. B. M. E. Box 587, AMERICAN MACHINIST.

Wanted—One patent office draftsman familiar with electrical work, for steady position with reliable concern in New York City. State age, experience and salary expected. Box 593, AMERICAN MACHINIST.

Draftsman, with 14 years' shop and office experience, locomotive design, special work, systematic rearrangement of equipment in machine, boiler shops, etc., to reduce unapplied labor and increase output. Box 506, AMERICAN MACHINIST.

Superintendent or general manager, 20 years' experience in machine shop, gray iron and brass foundries; largely hand, triplex power and steam pumps; designing, manufacturing and selling. American, technical graduate, practical, executive; very successful in reorganizing and modernizing for low cost production. Address Box 585, AMERICAN MACHINIST.

PENNSYLVANIA

First class gas engine draftsman and designer now employed, desires change. Fair technical education. Familiar with latest practice here and abroad. Box 581, AMERICAN MACHINIST.

Superintendent and designer, at present employed, is open for engagement; extensive experience on design of machine tools and tools and fixtures for interchangeable work. Technical education, age 39. Box 583, AMERICAN MA.

High-grade superintendent seeks position with progressive firm; thoroughly familiar with best modern practice in all departments. Expert designer of jigs and fixtures for rapid and accurate production. Experienced, energetic and a producer. Box 569, AMER. MACH.

Help Wanted

Classification indicates present address of advertiser, nothing else.

ILLINOIS

Wanted—A machine hand who is ambitious to work up to foremanship by going into the shop and operating various machine tools and proving his ability to get full output from machines. Then he will be given a chance to show what results he can get when directing other workmen. Box 580, AMER. MACHINIST.

Wanted—A gas engine expert to take charge of final test, inspection and checking-out department of a large gas engine factory. None but competent men need apply. Box 579, AM. MA.

MASSACHUSETTS

Wanted—Experienced tool designers for interchangeable manufacturing. Only first class men with excellent references need apply. Bresnahan Shoe Manufacturing Company, Lynn, Mass.

Sales manager wanted by growing concern manufacturing a line of high grade grinding machines. Previous experience in selling machine tools is absolutely necessary. Please write fully as to age, experience and salary expected. Box 591, AMERICAN MACHINIST.

MEXICO

Wanted—A civil engineer for position in Mexico City as engineer in charge of street railway track construction, maintenance and repair work. Must speak Spanish fluently and correctly. Best references required as to ability and habits. Steady employment. Address "M. T. Co.," Box 576.

MISSOURI

Wanted—High-grade, experienced machine tool salesman to travel in St. Louis territory. Box 571, AMERICAN MACHINIST.

NEW JERSEY

Wanted—In large manufacturing plant, superintendent of assembling department; not only a thorough machinist, but a judge of all kinds of machine work, with experience in manufacturing practice and capable of reorganizing a department. The kind of man wanted is one of skill and character now holding a good position, but desirous of advancement. Correspondence confidential. Box 572, AMERICAN MACHINIST.

NEW YORK

Wanted—Experienced machine designer to take complete charge of drafting room of large manufacturing concern. Man with experience on automatic machinery and tools preferred. Address "B. B.," care AMER. MACH.

Wanted—Foreman for grinding department, about 15 men employed on Brown & Sharpe and Landis machines, doing a line of very accurate manufacturing. Only men with experience and a knowledge of modern methods, such as accurate and rapid production, planing operations, making piece work prices, need apply. In replying, give full particulars as to age, experience of past six years, wages expected and references. Each applicant will be thoroughly looked up and only men with clean records need apply. Address Box 594, AMERICAN MACHINIST.

OHIO

Wanted—A hustling machine shop foreman for a gasolene motor factory; one who understands first class work and how to get it out. Give references and state experience fully. Box 206, Clyde, Ohio. AMER. MACH.

Wanted—At once, a strictly high grade machine tool salesman by an Ohio jobbing house. Must be practical mechanic and well educated with ability to advance. All correspondence strictly confidential. Box 577, care AMERICAN MACHINIST.

PENNSYLVANIA

Draftsman familiar with water turbines, centrifugal pumps, etc. State age, nationality, experience and salary expected. Box 589, AMERICAN MACHINIST.

For Sale

Classification indicates present address of advertiser, nothing else.

For Sale—Well established machine shop in Mississippi town of 12,000, been running 20 years, have no competition. R. C. Lynn, Yazoo City, Miss.

For sale, absolutely new, a No. 2½ heading machine and a No. 2½ reheading machine, Waterbury-Farrel make, never used. Ohlen Company, Box 740, Columbus, Ohio.

For Sale—United States letter patents of a perfected safety device of proved merit for applying to elevators. Sale necessitated by settlement of estate. Box 575, AMER. MACH.

For Sale—Tracings, patterns, jigs and templets for the following size gas and gasolene engines: 1½, 3 and 5 horse-power vertical and 3, 5, 8, 10, 12, 16 and 20 horse-power horizontal; also a number of finished and unfinished engines of the above sizes. All of the above sizes have been in successful operation for several years. This is a splendid opportunity for anyone wishing to build gas or gasolene engines. You can save thousands of dollars in experimental work by purchasing this complete outfit. Shop rights of valuable patents on these engines will be given to purchaser. Box 366, AMERICAN MACHINIST.

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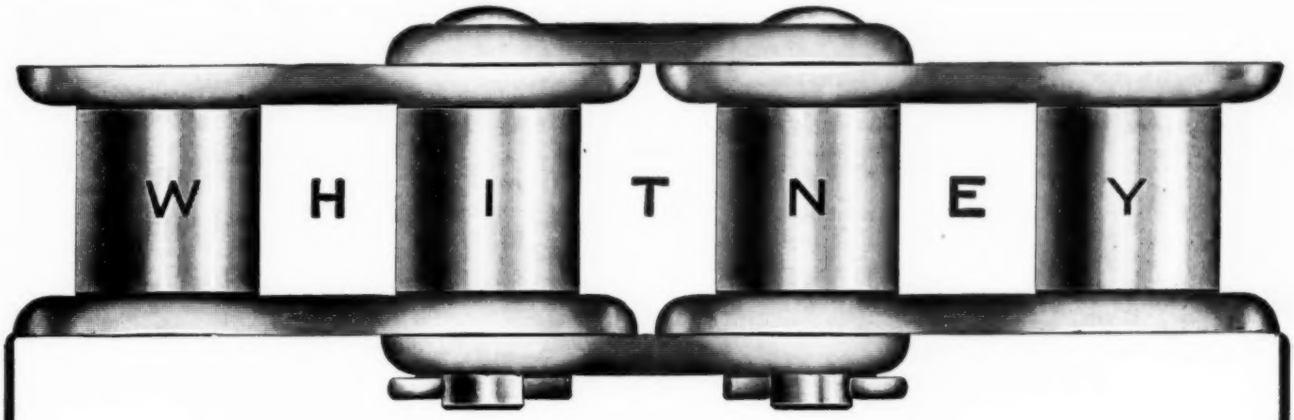

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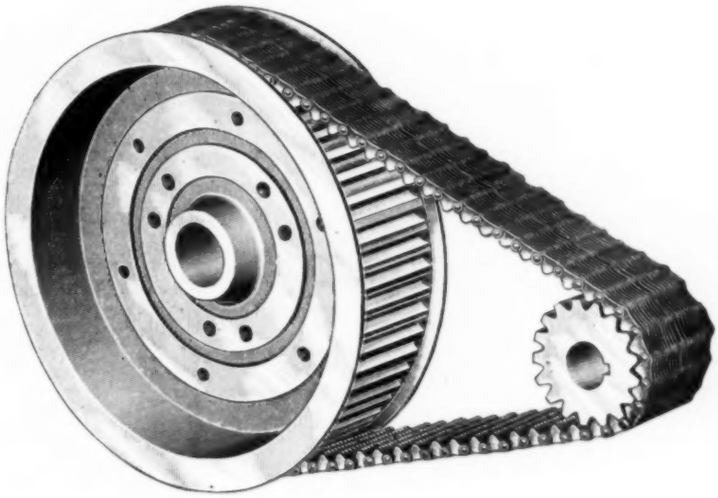

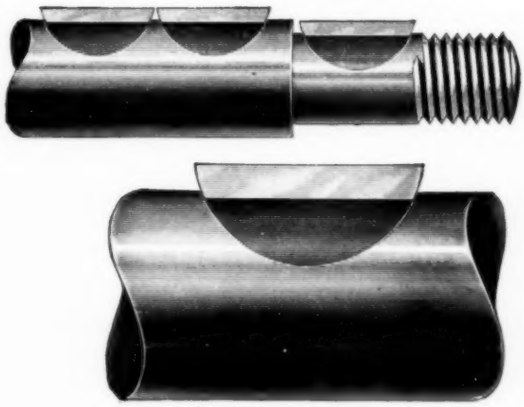

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Westinghouse Electric & Mfg. Co., Pittsburg, Pa

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Lamson Consolidated Store Service Co., Boston, Mass.
Link-Belt Co., Philadelphia, Pa.

Coping Machines

Long & Allstatter Co., Hamilton Ohio.
Niles-Bement-Pond Co., New York.

Corundum

See Grinding Wheels.

Cotters

Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, O.
Union Twist Drill Co., Athol, Mass.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Counterbores

Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Slocomb Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.

Counters, Revolution

Root Co., C. J., Bristol, Conn.
Schuchardt & Schutte, New York.
Veeder Mfg. Co., Hartford, Conn.

Countershafts

Almond Mfg. Co., T. R., Ashburnham, Mass.
Builders Iron Foundry, Providence, R. I.
Coates Clipper Mfg. Co., Worcester, Mass.
Evans Friction Cone Co., Newton Centre, Mass.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
McCabe, J. J., New York.
Norton Grinding Co., Worcester, Mass.
Safety Emery Wheel Co., Springfield, O.
Smith Countershaft Co., Boston, Mass.

Countershafts, Friction

Evans Friction Cone Co., Newton Centre, Mass.
Wilmarth & Morman Co., Grand Rapids, Mich.

Counting and Printing Wheels

Franklin Mfg. Co., H. H., Syracuse, N. Y.

Couplers, Hose

Independent Pneu. Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.

Couplings

Almond Mfg. Co., T. R., Ashburnham, Mass.
Caldwell & Son Co., H. W., Chicago, Ill.
Davis Machine Co., W. P., Rochester, N. Y.
Link-Belt Co., Philadelphia, Pa.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Gauge Steel Co., Beaver Falls, Pa.
Williams Fdry. & Mach. Co., Akron, Ohio.

Cranes

Brown Hoisting Mach. Co., Cleveland, O.
Case Mfg. Co., Columbus, O.
Cleveland Crane & Car Co., Wickliffe, Ohio.
Manning, Maxwell & Moore, Inc., New York.
Maris Bros., Philadelphia, Pa.
Nicholls, Wm. S., New York.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Obermayer Co., S., Cincinnati, O.
Pawling & Harnischfeger, Milwaukee, Wis.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Shepard Electric Crane & Hoist Co., Montour Falls, N. Y.

Cranes—*Continued.*

Vandyck Churchill Co., New York.
Yale & Towne Mfg. Co., New York.

Crank Pin Turning Machines

Niles-Bement-Pond Co., New York.
Underwood & Co., H. B., Philadelphia, Pa.

Crank Shafts

Standard Connecting Rod Co., Beaver Falls, Pa.

Crucibles

Dixon Crucible Co., Joseph, Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

Crushers

Farrel Fdry. & Mach. Co., Ansonia, Conn.
Niles-Bement-Pond Co., New York.
Link-Belt Co., Philadelphia, Pa.

Cupolas and Ladles, Foundry

Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.

Cups, Grease

Lunkenheimer Co., Cincinnati, O.

Cutters, Milling

Adams Co., Dubuque, Iowa.
Becker Milling Machine Co., Hyde Park, Mass.
Boker & Co., Hermann, New York.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Hardinge Bros., Chicago, Ill.
Harrison & Knight Mfg. Co., Newark, N. J.
Ingersoll Milling Mach. Co., Rockford, Ill.
Kearney & Trecker, Milwaukee, Wis.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Owen Mach. Tool Co., Springfield, Ohio.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, Jno. M., Gloucester City, N. J.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J.
Standard Tool Co., Cleveland, O.
Union Twist Drill Co., Athol, Mass.
Ward & Son, Edgar T., Boston, Mass.
Whitney Mfg. Co., Hartford, Conn.

Cutting-off Machines

Armstrong Bros. Tool Co., Chicago, Ill.
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Brown & Sharpe Mfg. Co., Providence, R. I.
Davis Machine Co., W. P., Rochester, N. Y.
Huriburt-Rogers Mach. Co., South Sudbury, Mass.
McCabe, J. J., New York.
Newton Mach. Tool Wks., Inc., Philadelphia, Pa.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Vandyck Churchill Co., New York.

Cutting-off Tools

Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Cleveland Twist Drill Co., Cleveland, O.
Fitchburg Machine Works, Fitchburg, Mass.
Krieger Tool & Mfg. Co., Chicago, Ill.
O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.

Diamond Tools

American Emery Wheel Co., Providence, R. I.
Dickinson, Thos. L., New York.
Safety Emery Wheel Co., Springfield, O.

Dies, Sheet Metal

American Tube & Stamping Co., Bridgeport, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Consolidated Press and Tool Co., Hastings, Mich.
Ferracute Mach. Co., Bridgeton, N. J.
Manville Bros. Co., Waterbury, Conn.

Dies, Sub-Press

Sloan & Chace Mfg. Co., Newark, N. J
Waltham Machine Works, Waltham, Mass.

Dies, Threading, Opening

Boker & Co., Hermann, New York.
Errington, F. A., New York.
Foote-Burt Co., Cleveland, O.
Geometric Tool Co., New Haven, Conn.
Jones & Lamson Machine Co., Springfield, Vt.
Pratt & Whitney Co., Hartford, Conn.

Drawing Boards and Tables

Alteneder & Son, Theo., Philadelphia, Pa.

Drawing Materials

Alteneder & Son, Theo., Philadelphia, Pa.
Kolesch & Co., New York.

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Universal Drafting Mach. Co., Cleveland, O.

Drilling Machines, Bench

American Watch Tool Co., Waltham, Mass.
Barnes Co., W. F. & John, Rockford, Ill.
Boynton & Plummer, Worcester, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Co., Worcester, Mass.
Rockford Drilling Mach. Co., Rockford, Ill.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg Co., Ltd , Newark, N. J
U. S. Electrical Tool Co.. Cincinnati, O.

Drilling Machines, Boiler

American Tool Works Co., Cin., O.
Bickford Drill & Tool Co., Cincinnati, O.
Boynton & Plummer, Worcester, Mass.
Foote-Burt Co., The, Cleveland, O.
Ingersoll-Rand Co., New York.
McCabe, J. J., New York.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.

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American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., W. F. & John, Rockford, Ill.
Baush Mach. Tool Co., Springfield Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Flather Planer Co., Mark. Nashua, N. H.
Foote-Burt Co., The, Cleveland, Ohio.
Fosdick Mach. Tool Co., Cin., O.
Hardinge Bros., Chicago, Ill.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Inc., Boston, Mass.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Newton Mach. Tool Works, Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Rockford Drilling Mach. Co., Rockford, Ill.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Slate Machine Co., Dwight, Hartford, Conn.
Taylor & Fenn Co., Hartford, Conn.

Drilling Machines, Portable

Cincinnati Elec. Tool Co., Cin., O.
Coates Clipper Mfg. Co., Worcester, Mass.
Gem Mfg. Co., Pittsburg, Pa.
Hisey-Wolf Mach. Co., Cin., O.
Ingersoll-Rand Co., New York.
Newton Machine Tool Wks., Inc., Phila., Pa
Niles-Bement-Pond Co., New York.
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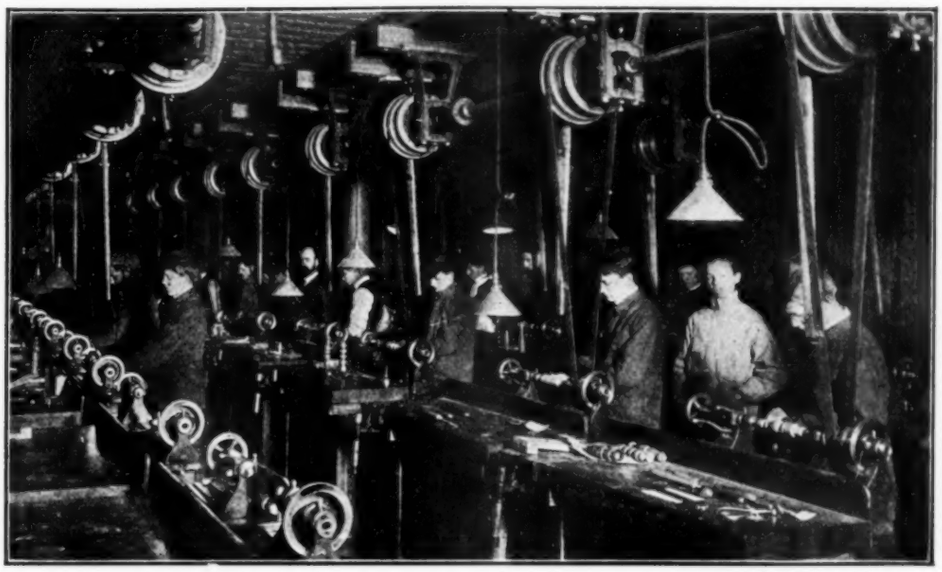
RUN YOUR MACHINES DIRECT FROM THE LINE SHAFT

by mounting Cones, Pulleys or Sprockets on

"JOHNSON FRICTION CLUTCHES"



NEW STUYVESANT HIGH SCHOOL, 16th St., near First Ave., New York, N. Y., showing the Wood-Turning and Pattern Making Shops, with 150 machines driven direct from the LINE SHAFT by CARLYLE JOHNSON FRICTION CLUTCHES.

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THE MECHANICS ARTS HIGH SCHOOL,	BOSTON, MASS.
THE UNIVERSITY OF TEXAS,	AUSTIN, TEXAS
THE UNIVERSITY OF TENNESSEE,	KNOXVILLE, TENNESSEE
THE UNIVERSITY OF MINNESOTA,	MINNEAPOLS, MINN.
MONTANA AGRICULTURAL COLLEGE,	BOZEMAN, MONTANA
NEW HAMPSHIRE COLLEGE,	DURHAM, N. H.
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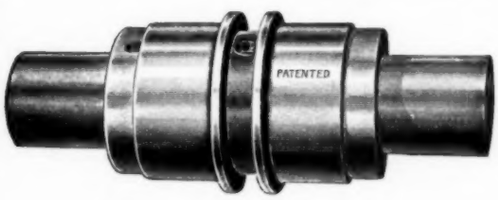

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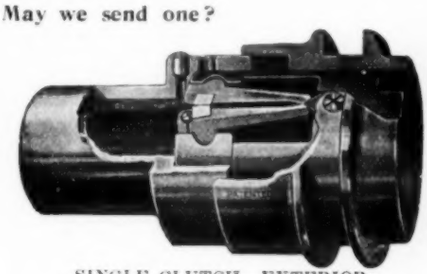

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Dreses Mach. Tool Co., Cin., O.
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Foote-Burt Co., Cleveland, O.
Fosdick Mach. Tool Co., Cin., O.
Gang Co., Wm. E., Cincinnati, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hilbert Mach. Co., Cincinnati, Ohio.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Morris Foundry Co., Jno. B., Cincinnati, O.
Mueller Mach. Tool Co., Cin., O.
Newton Mach. Tool Wks., Inc., Phila., Pa.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.
Wormer Mchy. Co., C. C., Detroit, Mich.

Drilling Machines, Rail

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Newton Machine Tool Wks., Inc., Phila., Pa.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Shepard Electric Crane & Hoist Co., Montour Falls, N. Y.
Standard Tool Co., Cleveland, O.

Drilling Machines, Turret

Fay Machine Tool Co., Phila., Pa.
Niles-Bement-Pond Co., New York.

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Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
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Cincinnati Mach. Tool Co., Cincinnati, O.
Davis Machine Co., W. P., Rochester, N. Y.
Fosdick Mach. Tool Co., Cin., O.
Foote-Burt Co., Cleveland, O.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
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Hill, Clarke & Co., Inc., Boston, Mass.
Hoefer Mfg. Co., Freeport, Ill.
Kern Mach. Tool Co., Cincinnati, O.
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Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Mechanics Machine Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Rockford Drilling Mach. Co., Rockford, Ill.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Sibley Machine Tool Co., South Bend, Ind.
Slate Mach. Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Taylor & Fenn Co., Hartford, Conn.
Vandyck Churchill Co., New York.
Whitney Mfg. Co., Hartford, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.
Wormer Mchry. Co., C. C., Detroit, Mich.

Drills, Center

Cleveland Twist Drill Co., Cleveland, O.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Slocomb Co., J. T., Prov., R. I.
Standard Tool Co., Cleveland, O.

Drills, Electric

Independent Pneumatic Tool Co., Chicago, Ill.
Van Dorn Elec. Co., Cleveland, Ohio.

Drills, Flat

Celfor Tool Co., Chicago, Ill.
Lincoln Williams Twist Drill Co., Taunton, Mass.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Drills, Hand

Cincinnati Electrical Tool Co., Cincinnati, O.
Coates Clipper Mfg. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cincinnati, O.

Drills, Pneumatic

Clayton Air Compressor Works, New York.
Independent Pneumatic Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.

Drills, Ratchet

Armstrong Bros. Tool Co., Chicago, Ill.
Boker & Co., Hermann, New York.
Cleveland Twist Drill Co., Cleveland, O.
Hisey-Wolf Mach. Co., Cin., O.
Parker Co., Chas., Meriden, Conn.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, John M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.

Drills, Rock

Ingersoll-Rand Co., New York.
Northern Electrical Mfg. Co., Madison, Wis.

Drill Speeder

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Emery Wheels

See Grinding Wheels.

Emery Wheel Dressers

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Bay State Stamping Co., Worcester, Mass.
Desmond-Stephan Mfg. Co., Urbana, O.
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Vitrified Wheel Co., Westfield, Mass.
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Engines, Steam

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Gem Mfg. Co., Pittsburg, Pa.

Forges

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Brown & Co., R. H., New Haven, Conn.
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U. S. Gas Furnace Co., Providence, R. I.
Westmacott Gas Furnace Co., Providence, R. I.

Furnaces, Electric

Hoskins Co., The, Chicago, Ill.

Furnaces, Gas

American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Rockwell Furnace Co., New York.
U. S. Gas Furnace Co., Providence, R. I.
Westmacott Gas Furnace Co., Providence, R. I.

Furnaces, Melting

American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.
Obermayer Co., S., Cincinnati, O.
U. S. Gas Furnace Co., Providence, R. I.
Westmacott Gas Furnace Co., Providence, R. I.

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Rockwell Furnace Co., New York.
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Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
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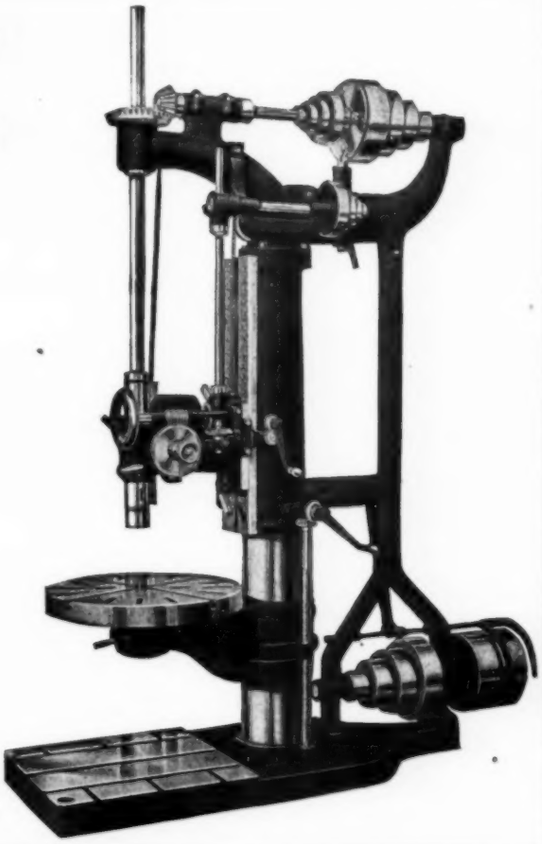

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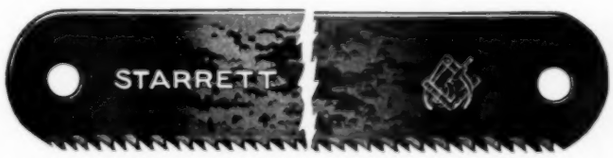

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Becker Milling Machine Co., Hyde Park, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Bilgram, Hugo, Philadelphia, Pa.
Brown & Sharpe Mfg. Co., Providence, R. I.
Buffalo Gear & Pattern Works, Buffalo, N. Y.
Cincinnati Shaper Co., Cincinnati, Ohio.
Fellows Gear Shaper Co., Springfield, Vt.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
McCabe, J. J., New York.
Newark Gear Cutting Machine Co., Newark, N. J.
Newton Machine Tool Works, Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Schuchardt & Schutte, New York.
Slate Machine Co., Dwight, Hartford, Conn.
Sloan & Chace Mfg. Co., Newark, N. J.
Spacke Mach. Co., F. W., Indianapolis, Ind.
Van Dorn & Dutton Co., Cleveland, O.
Walcott & Wood Mach. Tool Co., Jackson, Mich.
Waltham Machine Works, Waltham, Mass.
Whiton Machine Co., D. E., New London, Conn.

Gear Testing Machinery

Gisholt Mach. Co., Madison, Wis.

Gears, Cut

Bilgram, Hugo, Philadelphia, Pa.
Boston Gear Works, Norfolk Downs, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Buffalo Gear & Pattern Works, Buffalo, N. Y.
Caldwell & Son Co., H. W., Chicago, Ill.
Chicago Raw Hide Mfg. Co., Chicago, Ill.
Davis, Rodney, Philadelphia, Pa.
Earle Gear & Machine Co., Philadelphia, Pa.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Fawcus Mach. Co., Pittsburg, Pa.
Fellows Gear Shaper Co., Springfield, Vt.
Gleason Works, Rochester, Mass.
Gould & Eberhardt, Newark, N. J.
Grant Gear Works, Boston, Mass.
Hardinge Bros., Chicago, Ill.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Horsburgh & Scott Co., The, Cleveland, Ohio.
Lea Equipment Co., New York.
Newark Gear Cutting Machine Co., Newark, N. J.
New Process Rawhide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Owen Machine Tool Co., Springfield, Ohio.
Picrome Hide Co., Syracuse, N. Y.
Philadelphia Gear Works, Philadelphia, Pa.
Sawyer Gear Works, Cleveland, O.
Spacke Mach. Co., F. W., Indianapolis, Ind.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.
Van Dorn & Dutton Co., Cleveland, O.
Walcott & Wood Mach. Tool Co., Jackson, Mich.

Gears, Molded

Caldwell & Son Co., H. W., Chicago, Ill.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Franklin Mfg. Co., H. H., Syracuse, N. Y.
Horsburgh & Scott Co. The, Cleveland, Ohio.
Philadelphia Gear Works, Philadelphia, Pa.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.

Gears, Molded—*Continued.*

Van Dorn & Dutton Co., Cleveland, O.

Gears, Quride

Picrome Hide Co., Syracuse, N. Y.

Gears, Rawhide

Boston Gear Works, Norfolk Downs, Mass.
Chicago Raw Hide Mfg. Co., Chicago, Ill
Earle Gear & Mach. Co., Philadelphia, Pa.
Fawcus Mach. Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Grant Gear Works, Boston, Mass.
Horsburgh & Scott Co., The, Cleveland, O.
New Process Rawhide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Sawyer Gear Works, Cleveland, O.
Van Dorn & Dutton Co., Cleveland, O.

Gears, Worm

Albio-Clem Elevator Co., Philadelphia, Pa.
Boston Gear Works, Norfolk Downs, Mass.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Fawcus Machine Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Horsburgh & Scott Co., The, Cleveland, O.
Newark Gear Cutting Machine Co., Newark, N. J.
Nuttall Co., R. D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Picrome Hide Co., Syracuse, N. Y.
Taylor-Wilson Mfg. Co., McKees Rocks, Pa.
Van Dorn & Dutton Co., Cleveland, O.

Generating Sets

Burke Electric Co., Erie, Pa.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Northern Electrical Mfg. Co., Madison, Wis.
Roth Bros. & Co., Chicago, Ill.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Electric Co., Cincinnati, O.

Generators, Gas

American Gas Furnace Co., New York.

Graphite

Dixon Crucible Co., Jos., Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

Grinders, Center

Cincinnati Electrical Tool Co., Cincinnati, O.
Coates Clipper Mfg. Co., Worcester, Mass.
Clark, Jr., Elec. Co., Inc., James, Louisville, Ky.
Gem Mfg. Co., Pittsburg, Pa.
Heald Mach. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincinnati, O.
Mueller Machine Tool Co., Cincinnati, O.
Niles-Bement-Pond Co., New York.
U. S. Electrical Tool Co., Cin., O.

Grinders, Cutter

Bath Grinder Co., Fitchburg, Mass.
Becker Milling Mach. Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Machine Co., Cincinnati, O.
Crocker-Wheeler Co., Ampere, N. J.
Garvin Machine Co., New York.
Gould & Eberhardt, Newark, N. J.
Heald Mach. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll Milling Mach. Co., Rockford, Ill.
LeBlond Mach. Tool Co., R. K., Cincinnati, Ohio.
McCabe, J. J., New York.
Niles-Bement-Pond Co., New York.
Norton Grinding Co., Worcester, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Rivett Lathe Mfg. Co., Boston, Mass.
U. S. Electrical Tool Co., Cincinnati, O.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinders, Cylindrical

Bath Grinder Co., Fitchburg, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Heald Mach. Co., Worcester, Mass.
Landis Tool Co., Waynesboro, Pa.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Norton Grinding Co., Worcester, Mass.

Grinders, Disc

Bath Grinder Co., Fitchburg, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Diamond Machine Co., Providence, R. I.
Gardner Machine Co., Beloit, Wis.
Heald Mach. Co., Worcester, Mass.
Ransom Mfg. Co., Oshkosh, Wis.
Safety Emery Wheel Co., Springfield, Ohio.
Taylor & Fenn Co., Hartford, Conn.

Grinders, Drill

Heald Mach. Co., Worcester, Mass.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Niles-Bement-Pond Co., New York.
Safety Emery Wheel Co., Springfield, Ohio.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Tool Co., Cleveland, O.
U. S. Electrical Tool Co., Cincinnati, Ohio.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinders, Internal

Bath Grinder Co., Fitchburg, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Heald Mach. Co., Worcester, Mass.
Landis Tool Co., Waynesboro, Pa.
Rivett Lathe Mfg. Co., Boston, Mass.
U. S. Electrical Tool Co., Cincinnati, O.

Grinders, Knife

American Wood Working Mchy. Co., Rochester, N. Y.
Safety Emery Wheel Co., Springfield, O.

Grinders, Portable

Cincinnati Electrical Tool Co., Cincinnati, O.
Coates Clipper Mfg. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincinnati, O.
U. S. Electrical Co., Cincinnati, Ohio.

Grinders, Tool

Armstrong Bros. Tool Co., Chicago, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Bath Grinder Co., Fitchburg, Mass.
Blount Co., J. G., Everett, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Electrical Tool Co., Cincinnati, O.
Cincinnati Milling Machine Co., Cincinnati, O.
Diamond Machine Co., Providence, R. I.
Gisholt Mach. Co., Madison, Wis.
Gould & Eberhardt, Newark, N. J.
Grant Mfg. & Mach. Co., Bridgeport, Conn.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Heald Mach. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Landis Tool Co., Waynesboro, Pa.
LeBlond Machine Tool Co., R. K., Cincinnati, Ohio.
McCabe, J. J., New York.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Mummert, Wolf & Dixon Co., Hanover, Pa.
Niles-Bement-Pond Co., New York.
Norton Grinding Co., Worcester, Mass.
Ransom Mfg. Co., Oshkosh, Wis.
Rivett Lathe Mfg. Co., Boston, Mass.
Rockford Drilling Mach. Co., Rockford, Ill.
Safety Emery Wheel Co., Springfield, O.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Tool Co., Cleveland, O.
Tabor Mfg. Co., Phila., Pa.
U. S. Electrical Tool Co., Cincinnati, O.
Vandyck Churchill Co., New York.
Vitrified Wheel Co., Westfield, Mass.
Whitney Mfg. Co., Hartford, Conn.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinding or Polishing Machinery

Abrasive Material Co., Philadelphia, Pa.
American Emery Wheel Co., Providence, R. I.
Barnes Co., W. F. & John, Rockford, Ill.
Bath Grinder Co., Fitchburg, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Blount Co., J. G., Everett, Mass.
Brown & Sharpe Mfg. Co,. Providence, R. I.
Builders Iron Foundry, Providence, R. I.
Chicago Machine Tool Co., Chicago, Ill.
Cincinnati Electrical Tool Co., Cincinnati, O.
Coates Clipper Mfg. Co., Worcester, Mass.
Crocker-Wheeler Co., Ampere, N. J.
Diamond Machine Co., Providence, R. I.
Gardner Mach. Co., Beloit, Mich.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Heald Machine Co., Worcester, Mass.
Hill, Clarke & Co., Inc., Boston, Mass.
Hisey-Wolf Mach. Co., Cincinnati, O.
Landis Tool Co., Waynesboro, Pa.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Newton Machine Tool Works, Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Northern Electrical Mfg. Co., Madison, Wis.
Norton Grinding Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Ransom Mfg. Co., Oshkosh, Wis.
Roth Bros. & Co., Chicago, Ill.
Safety Emery Wheel Co., Springfield, O.
U. S. Electrical Tool Co., Cincinnati, O.
Vandyck Churchill Co., New York.
Vitrified Wheel Co., Westfield, Mass.

Grinding Wheels

Abrasive Material Co., Philadelphia, Pa.
Adams Co., Dubuque, Iowa.
American Emery Wheel Co., Providence, R. I.
Carborundum Co., Niagara Falls, N. Y.
Coates Clipper Mfg. Co., Worcester, Mass.
Diamond Machine Co., Providence, R. I.
Dickinson, Thos. L., New York.
Niles-Bement-Pond Co., New York.
Norton Co., Worcester, Mass.
Safety Emery Wheel Co., Springfield, O.
Vitrified Wheel Co., Westfield, Mass.
Whitney Mfg. Co., Hartford, Conn.

Grindstones and Frames

Cleveland Stone Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Norton, Co., Worcester, Mass.

Gun Barrel Machinery

Diamond Machine Co., Providence, R. I.
Pratt & Whitney Co., Hartford, Conn.
Reed Co., F. E., Worcester, Mass.

Hammers, Drop

Bliss Co., E. W., Brooklyn, N. Y.
Bradley & Son, C. C., Syracuse, N. Y.
Chambersburg Engineering Co., Chambersburg, Pa.
Gould & Eberhardt, Newark, N. J.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Waterbury Farrel Fdry. & Mach. Co., Waterbury, Conn.

Hammers, Pneumatic

Bliss Co., E. W., Brooklyn, N. Y.
Clayton Air Compressor Works, New York.
Independent Pneumatic Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Hammers, Power

Bradley & Son, C. C., Syracuse, N. Y.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Toledo Machine & Tool Co., Toledo, Ohio.